"EVALUATION OF MEAN 'R' WAVE AMPLITUDE IN LEAD V1 OF ECG AMONG TERM NEWBORN INFANTS"

A Dissertation Submitted In
Partial Fulfillment Of The Requirements
For The Degree Of Doctor Of Medicine (M.D)
BRANCH VII - PAEDIATRIC MEDICINE

GOVT KILPAUK MEDICAL COLLEGE
THE TAMILNADU Dr.M.G.R MEDICAL UNIVERSITY
CHENNAI - 600032
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BY

DR.HARIHARAN.N

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UNDER THE GUIDANCE OF

PROF.**DR.B.SATHYAMURTHI .MD(PAED),DCH.**

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CERTIFICATE

This is to certify that this dissertation entitled **"EVALUATION OF MEAN 'R' WAVE AMPLITUDE IN LEAD V1 OF ECG AMONG TERM NEWBORN INFANTS"** submitted by **Dr.HARIHARAN.N** in partial fulfillment for the award of the degree Doctor of Medicine in Paediatrics by **The Tamilnadu Dr.M.G.R. Medical University,Chennai** isa bonafide work done by him at **GOVERNMENT KILPAUK MEDICAL COLLEGE, CHENNAI** during the academic year 2013-2016.

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DECLARATION BY THE GUIDE

This is to certify that this dissertation entitled **"EVALUATION OF MEAN 'R' WAVE AMPLITUDE IN LEAD V1 OF ECG AMONG TERM NEWBORN INFANTS"** submitted by **Dr.HARIHARAN.N** in partial fulfillment for the award of the degree Doctor of Medicine in Paediatrics by **The Tamilnadu Dr.M.G.R. Medical University, Chennai** is a bonafide work done by him at **GOVERNMENT KILPAUK MEDICAL COLLEGE, CHENNAI** during the academic year 2013-2016, under my guidance and supervision.

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DECLARATION

I, **Dr.HARIHARAN.N**, solemnly declare that this dissertation, entitled "**EVALUATION OF MEAN 'R' WAVE AMPLITUDE IN LEAD V1 OF ECG AMONG TERM NEWBORN INFANTS**", has beenprepared by me, under the expert guidance and supervision of **Prof.B.SATYAMURTHY .MD(PAED),DCH.**, Professor of paediatrics, Department ofPaediatrics, Government Kilpauk Medical College and Hospital, Chennai and submitted in partial fulfillment of the regulations for the award of the degree **M.D.(Paediatrics)** by **The Tamil Nadu Dr. M.G.R. Medical University** and the examination to be held in April 2016.

This study was conducted at Government Kilpauk Medical College Hospital , Chennai. I have not submitted thisdissertation previously to any university for the award of any degree or diploma.

Place: Chennai (DR.HARIHARAN.N)

Date:

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INSTITUTIONAL ETHICAL COMMITTEE
GOVT.KILPAUK MEDICAL COLLEGE,
CHENNAI-10
Protocol ID. No.8/02/2015 Dt:01/02/2015
CERTIFICATE OF APPROVAL

The Institutional Ethical Committee of Govt. Kilpauk Medical College, Chennai reviewed and discussed the application for approval "Evaluation of mean Qrs amplitude in lead v1 of ECG among term newborn infants"- For Project Work submitted by Dr.Hariharan.N, Post Graduate in MD (Paed), Govt. Kilpauk Medical College, Chennai.

The Proposal is APPROVED.

The Institutional Ethical Committee expects to be informed about the progress of the study any Adverse Drug Reaction Occurring in the Course of the study any change in the protocol and patient information /informed consent and asks to be provided a copy of the final report.

CHAIRMAN,
Ethical Committee
Govt. Kilpauk Medical College, Chennai

o/c

Received
8/6/15

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"EVALUATION OF MEAN 'R' WAVE AMPLITUDE IN LEAD V1 OF ECG AMONG TERM NEWBORN INFANTS"

BACKGROUND

Most of the age related changes in paediatric ecgs are related to the changes in the ratio of left ventricle to the right ventricle weight.At birth the right ventricle is thicker than the left ventricle. Physiological right ventricular dominance is seen in the newborn babies .normal values of QRS voltages vary by race.African-americans have a higher limit upper normal limit of QRS voltages than do the euro-americans.

OBJECTIVE

To determine the mean QRS complex amplitude in Lead V1 of standard 12 lead ECG

MATERIALS AND METHODS

The material consisted of 76 term newborn infants of which are males and are females. The newborn infants were examined clinically, and echocardiography was done before doing the electrocardiography in the Kilpauk medical college and hospital, Chennai. The data of each child is collected in the specific proforma that includes the newborn name, age(hrs of life),sex, parity of the mother

The detailed echocardiography was done by the cardiologist to rule out the congenital heart disease. After ruling out the congenital heart disease by the echo ,the baby is taken to the ecg room for taking the electrocardiogram.

A 12 lead Electrocardiogram was recorded using the portable heat writing electrocardiograph with the frequency range of 0-150 Hz and the sampling frequency of 1000 Hz.Special newborn disposable electrodes are used and the electrodes are positioned as recommended by the American heart association

CONCLUSIONS

1. The mean R wave amplitude was 11.56mm with SD of 2.96 mm with 5 th and 95th percentile 6.85 mm and 16.15 mm respectively for the Indian population.

2. The mean QTc inv observed by the bazett formula was 405.49 ms with sd of 42.013 with 5th percentile & 95th percentile of 330.55 and 472.75 ms respectively.

3. The mean QTc interval Fridericia formula 357.14 ms, sd of 34.072ms with 95%CI for mean349.36-364.93 ms. The measurement of QTc by fridericia formula predicts QTc more correctly in the new born since the newborn heart rate is usually more than 100/min

4. The mean heart rate was 125.75/min with the sd of 15.44 with 5^{th} and 95^{th} percentile 93.7&149 /min respectively.

5. The mean PR inv was 102.67 ms with SD of 12.978 with 5^{th} and 95^{th} percentile 82&126.15 ms respectively.

6. The mean QRS duration was 61.47 ms with SD of 8.709 with 5th percentile & 95th percentile of 44.8 and 76 ms respectively

7. The mean P wave axis in Indian population was 44.72 degree , 5&95^{th} percentile of 22&70 respectively.

8. The mean QRS wave axis in Indian population was 115.49 degree , 5&95^{th} percentile of 91&151 respectively

9. The mean T wave axis in Indian population was 39.87 degree , 5&95^{th} percentile of -19&62 respectively

KEYWORDS:

Ecg, R wave amplitude, newborn,lead v1`, Qtc interval, right ventricular hypertrophy

INTRODUCTION

The Heart –first functional organ formed during the process of embryogenesis. Heart starts beating at 22-23 days of embryo and blood circulation begins during the 4^{th} week of life. It is important for the survival of the embryo.During the period evolution,the septation and circulation pathway becomes the complexed one. For example,fish has the single atrium and the ventricle; Frog has the two atrium and the single ventricle; human heart has the two atrium and the ventricles. Understanding the cardiac structure and function ,of the fish, leads to the discovery of the Fontan pathway-the procedure done for the

1.Tricuspid atresia

2.Double inlet ventricle

3.Hypoplastic left heart syndrome.

4. pulmonary atresia with intact ventricular septum.

Many congenital heart diseases arises because of the defects in the septation and the partitioning of the heart

Most of the changes in newborn and the paediatric ecg s are age related. It is due to the changes in the ratio of left ventricle to the right ventricle weight. At birth the right ventricle is thicker than the left ventricle. Physiological right ventricular dominance is seen in newborn babies.

Contradictory and the complicated regarding the physiological and biochemical aspects of cardiac hypertrophy are less enigmatic if we discern whether the type of hypertrophy analyzed is physiological or pathological, (that is) whether factors secondary to the process of hypertrophy have induced the heart to augment or depress its mechanical function. Physiological hypertrophy -hypertrophy of the heart associated with the increased or normal contractile force and in that the muscle shortening is either increased or normal. Pathological hypertrophy is associated with the depressed contractility without necessarily concordant heart failure, in which case velocity of muscle and the rate of myosin ATPase shortening are decreased. Both types of hyper trophy are considered as compensatory in that the heart biochemically and physiologically adjusts to cellular alterations that occur according to the severity of the workload.

The newborn cardiovascular system differs from the fetal and the paediatric .A term newborn must successively pass through the changes in the lung volume ,preload& afterload of the right and the left heart. Central shunts and the extra cardiac shunts have the variable effects on the postnatal hemodynamics.

The fetal circulatory system includes,

. low resistance placental circulation,

. patent foramen ovale&

. ductus arteriosus

Because of the above systems the R.V output bypasses the lung which is high resistance. After birth, major changes occur in the blood flow pattern and the cardiovascular function as the process of adaption to the new environment. Three important adaptions are

1. Both ventricular output increases to the maximum to meet the energy expenditure for the thermoregulation and the work of breathing.

2. Pulmonary blood flow increases to the major amount- 20 times when compared to the pulmonary circulation in the fetus.

3. Changes in the central blood flow

The abolition of central shunts and the blood flow alteration ,converts the circulation in parallel to the circulation in series.

We can screen the child for the ventricular hypertrophy by the echocardiography or the electocardiogrphy. But doing the newborn Echocadiography is the difficult process because it requires the skillful paediatric cardiologist,coperative newborn and it is time consuming.When compared to the adults ,the newborn echocardiogram is difficult because of the following points.

1. In the newborn first we have to proceed from the situs position (situs solitus/situs inversus)
2. Then we have to analyze the whether the systemic veins are draining to the right atrium or any other anamolous venous connections are present.
3. Atrio-ventricular concordance or discordance
4. Ventriculo- Arterial concordance or discordance
5. Apart from the normal views ,we have to go for the some special views like Subcostal views(long axis &short axis), suprasternal views.To obtain these views ,the sonographer require special training and it is also time consuming.

So,doing the echo for the newborn as a screening tool for detecting the congenital heart diseases is somewhat difficult and time consuming. But ,doing the electrocardiogram is easy and it is less time consuming.

AIM AND OBJECTIVES

OBJECTIVE

To determine the mean QRS complex amplitude in Lead V1 of standard 12 lead ECG

BACKGROUND

Most of the age related changes in paediatric ecgs are related to the changes in the ratio of left ventricle to the right ventricle weight.At birth the right ventricle is thicker than the left ventricle. Physiological right ventricular dominance is seen in the newborn babies (1).normal values of QRS voltages vary by race.African-americans have a higher limit upper normal limit of QRS voltages than do the euro-americans(2)

JUSTIFICATION OF STUDY

- In newborn normally right ventricular hypertrophy is seen. It is essential to determine the mean QRS amplitude in normal newborn to differentiate between newborn physiological hypertrophy and pathological hypertrophy.
- Previous studies were conducted among African American population and this is the first study in Indian population

STUDY DESIGN - descriptive cross sectional study

STUDY GROUP

Term newborn infants within 3 days of life

SAMPLE SIZE

n=72

$$n=\frac{?^{?\times}?(???)}{??}$$

n=required sample size

t=confidence level at 95%(standard value of 1.96)

p=5% variation expected compared to reference value of previous study

m= margins of error at 5% (standard value of 0.05)

$$n=\frac{?.??\times?.??\times?.??\times?.??}{?.??\times?.??}$$

n=72

PLACE OF STUDY

Department of Paediatrics, Kilpauk Medical College Hospital,Chennai.

DURATION OF STUDY -1 YEAR

INCLUSION CRITERA

- Term
- 0-3 days of life

EXCLUSION CRITERIA

- Sick babies
- >3 days of life
- Infant of diabetic mother
- Resuscitated babies
- New born with congenital heart disease

DATA MANAGEMENT AND STATISTICAL ANALYSIS

Study design – descriptive cross sectional study

Sample size – 72

STATISTICAL TOOL

X^2 for discrete variables

T test for continuous variables

RESULTS OF PREVIOUS STUDIES

1.Sudy conducted by valimaki-recording of electrocardiogram in newborn infants

Acta paediatrica.scand supplement:1969:180-199

Mean R wave voltage in V1 is 1.26mV

2. AHA/ACCF/HRS Recommendations

for the Standardization and Interpretation

of the Electrocardiogram vol.53 no.11.2009

QRS voltages vary by race

REVIEW OF LITERATURE:

1. Valimaki et al (1) In V1, the mean 'R' wave Amplitude was 12.6mm with the range of 6mm-19mm in the study conducted in the newborns of municipal maternity hospital,Turku.

2.Afolabi Joseph Kolawole et al(2) study mean R wave Amplitude in V1 was 15mm with 2^{nd} and 98^{th} percentile 4 and 26 mm respectively in newborn of 0-7 days of life in Ilorin ,Nigeria.

3.Rijnbeek (3) the mean 'R' wave amplitude(V1), in that study was 11mm with 98^{th} percentile of 20.5mm&mean R wave amplitude in (V6) was 10 mm with 98^{th} percentile of 17.8mm in the age group of 0-1 month.

4.Lue et al(4) study showed that the mean R wave amplitude in V1 was 8.6mm+/-3.5 mm with 5^{th} and 95^{th} percentile was 3.5 mm and 15.1 mm respectively in newborn 1-3 days of life.

5.William Hancock et al(5) in JACC,for the pathological right ventricular hypertrophy had given the cut off of 27mm and the study also tells that African-american population will have the upper normal range of QRS amplitude than the others.

6. Marti –Almor et.al(6) study showed that in Spanish newborn in the first 48 hrs of life ,the mean QTc by Bazett formula was 417.79 ms with sd of 28.47 ms. In the same study he mentioned that 28.2% of Indian and Pakistani newborn infants has prolonged QTc inv compared to 17.9% of the Spanish newborn , when they used the Bazett formula.

7. Lue et al(7),the mean QTc inv (bazett) was 412ms withy sd of 23.09 with 5^{th} percentile & 95th percentile of 380 and 451 ms respectively in the 1-3 days of life.

8 . Afolabi Joseph Kolawole, S.I.Omokhodion(2), the mean QTc inv was 400ms with 2and 98 percentile were 350 and 470 ms respectively in the newborn 0-7 days of life.

Bazett's formula, is the most commonly used formula due to its simplicity. It over-corrects at heart rates > 100 bpm and under-corrects at heart rates < 60 bpm, but provides an adequate correction for heart rate ranging from 60 – 100 bpm. At heart rates outside of the 60 – 100 bpm range, the Fredericia or Framingham corrections are more accurate and should be used instead(8)

9.Lue et.al.(9) study showed that the in first 72 hrs of life the mean heart rate was132/min with the sd of 13.07 with 5^{th} and 95^{th} percentile were 111& 152 respectively.

10. Davignon et.al(10)study ,the mean heart rate was 145/min,(range :90-180) in the newborn infants of Montreal

11. Afolabi Joseph Kolawole, S.I.Omokhodion (2),the mean PR inv was 120 ms with 2^{nd} and 98^{th} percentile 80&140 respectively in 0-7 days newborn in the Nigerian population

12. Davignon et.al(10) ,the mean PR inv was 100ms in the newborn infants of Montreal

13. Lue et al(11) study,the mean QRS duration was 71 ms with SD of 11.5 with 5th percentile & 95th percentile of 57 and 89 ms respectively in 1-3 days of life of newborn.

14.Edemeka et al the mean S wave amplitude in V6 was 3 mm with the 2nd and 98 the percentile were 0 and 12 mm respectively(12)

15. P. J. Schwartz1 (Chair), A. Garson, Jr et.al ,Europian society of cardiology in " Guidelines for the interpretation of the neonatal electrocardiogram" ,the mean value of frontal QRS axis is 135degrees with 2^{nd} and 98^{th} percentile was 64 and 197 respectively(13)

MORPHOGENETIC CARDIAC EMBRYOLOGY

Cardiogenesis involves orchestrated series of morphogenetic and the molecular events that combines the cell types from various lineages. The Heart - first formed functionally important organ and it is crucial for sustaining the life of the developing embryo.The cardiac septation and the patterning of the heart is extremely sensitive to the perturbations. The evidence for this is 'approximately 11% of early trimester abortions are due to the severe form of congenital heart diseases.

EARLY CARDIOGENESIS:

DETERMINATION OF THE CARDIOGENIC MESODERM:

The first step in the development of heart is the specification of cells that give raise to the functioning heart.

Mesodermal cells(in primitive streak)

|

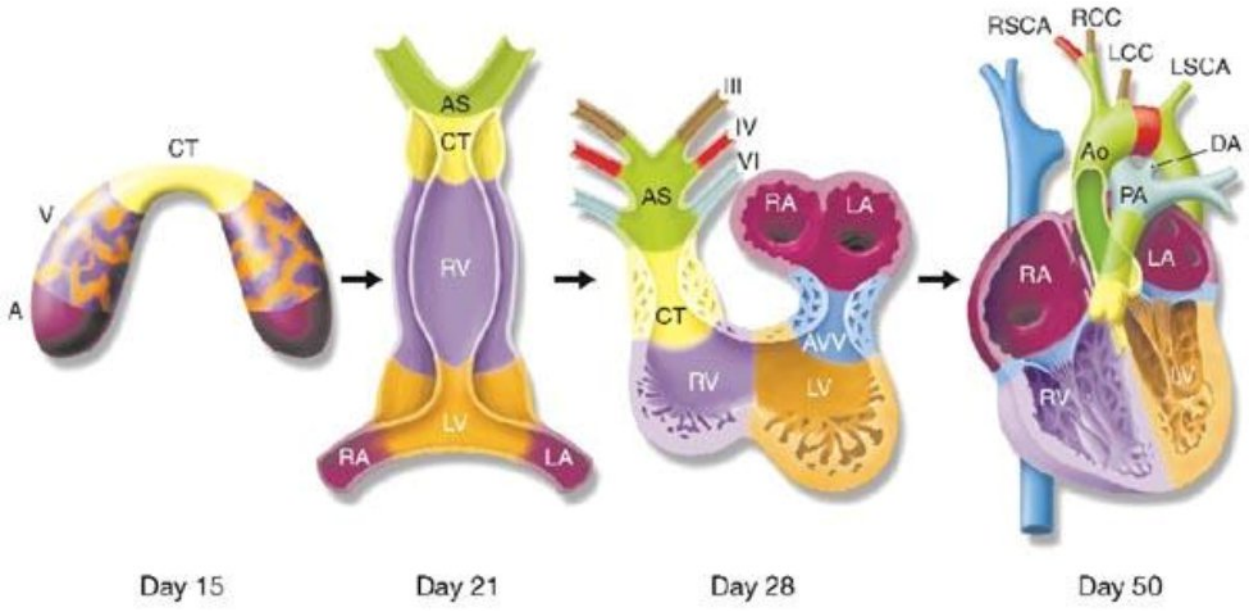
Cardiac progenitor cells

|

Migration to lateral plate mesoderm

Cardiac progenitor cells are derived from the mesodermal cells in the anterior portions of the primitive streak.The progenitor cells migrate to the lateral plate mesoderm.The signaling molecules arises from the adjacent endoderm promote cardiac specification, at the same time inhibitory signals coming from the neural plate and axial mesoderm delineate the lateral and medial margins of the cardiac region.By 15th day in the embryo, cardiogenic mesoderm assumes the bilaterally symmetrical crescent shape in lateral plate mesoderm.(14).Cells in cardiogenic mesoderm committed to become the myocardial fate through the interaction of transcription factors that regulate the expressions of the cardiac specific genes. Nkx 2.5, transcription factor plays the crucial role in cardiac determination. Other

transcription factors involved are GATA 4and TBX5.mutations in the above genes found in the spectrum structural and the conduction defects.(15) (16)

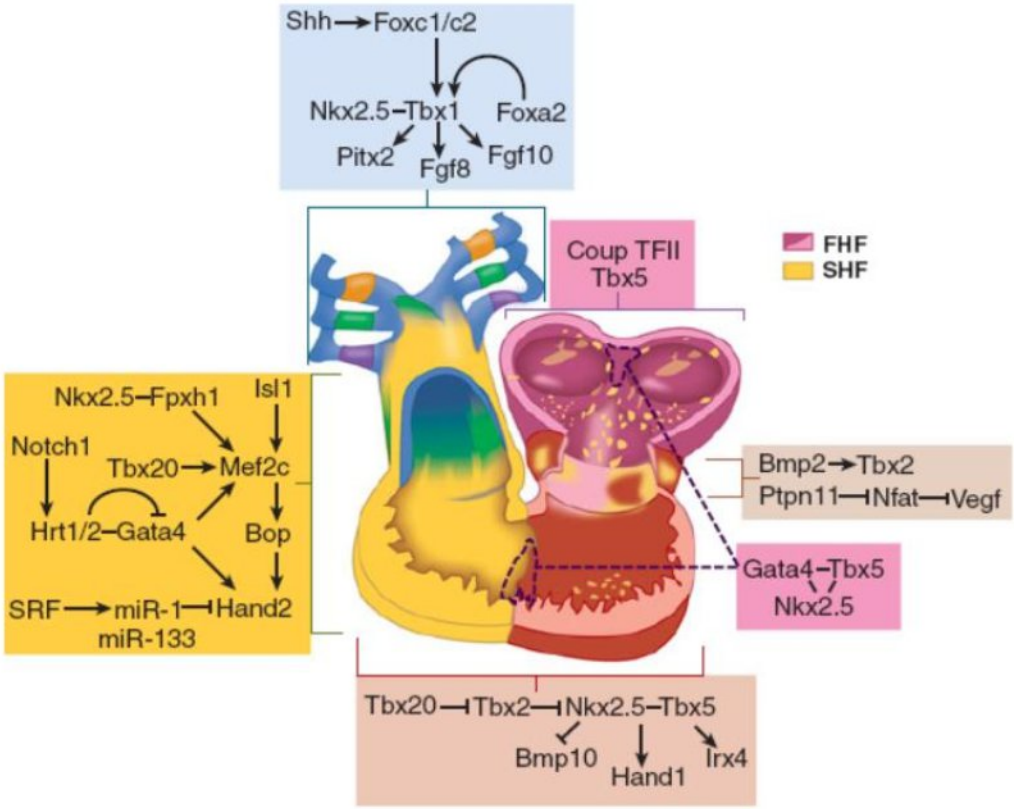


Heart field patterning:

During the 3rd week of gestation, crescent cells start to differentiate and joins in the ventral mid-line to form a primitive heart tube. Classic cell-labelling studies proved that cardiac progenitor cells were patterned along the antero-posterior axis of cardiac crescent. The heart tube is formed from the differentiation of 1st heart

field cells . The 2nd heart field discovered recently consists of mesodermal cells that lie medial to the 1st heart field cardiac crescent. When the cardiac- crescent fuses in the mid-line, 2nd heart field cells migrate in mesoderm (pharyngeal) to position posterior to the developing heart tube(17). When the heart tube starts to loop rightward, second heart tube cells are added to both arterial and venous poles and multiply to populate a major portion of the developing heart thought to be derived from the primitive heart tube. Myocardial precursor cells from this region gives rise to left ventricle and some part of atria **.**

While the rest of atria, right ventricle and outflow tract are derived from second heart field.



Pathways regulating cardiac morphogenesis

1st heart field cells in the cardiac crescent

Differentiation ↓

Functioning cardiac myocytes and form primitive heart tube

. In contrast 2nd heart field cells remain in committed state but remains undifferentiated. The 2nd cells lies medial to the first heart field during the crescentic stage and closer to the segments coming from the mid-line of the embryo and that inhibit the cardiac differentiation of second heart field(18). Nkx2.5 expressed in first

and second heart field cells at the stage of the crescent and marks both populations as committed myocyte precursors. As opposed to transcription factor Islet1(Isl1) which is initially expressed in all cardiac progenitors is now downregulated in the first heart field as these cells started to express differentiation markers but Isl1 expression is maintained in 2 nd heart field . The gene deletion studies of Isl1 in mice reveals that those embryonic hearts lacking much of atria, right ventricle and outflow tract consistent with the important play of Isl1 in regulation 2 nd heart field cells(19).

CARDIAC MORPHOGENESIS

FORMATION OF HEART TUBE AND CARDIAC LOOPING

The first heart field derived cardiac crescentic cells differentiate into cardiac myocytes. These cells migrate ventrally and join in the midline to create the beating linear heart tube. The linear heart tube consists of

1.outer layer (myocardial cells)&

2. inner layer (endothelial cells)

interposed by extracellular matrix known as Cardiac Jelly. This is the first functioning organ of the embryo. The linear heart tube further undergoes the

morphogenetic changes that ends in the rightward looping of heart tube and movement of tail end to the more head end and dorsal position. As the heart tube bends along the AP axis, it starts rotating to right such that

ventral surface of the tube →outer curvature of cardiac loop and

dorsal surface →inner curvature(20).

The "Ballooning Model" of formation of the chambers tells that, the inner curvature remodels to align the developing atrio-ventricular canal, outflow tract and inflow tract. When the 2nd heart field cells added to two ends of the tubular heart during the process of looping, the ventricle starts to develop along the cranial aspect of outer curvature followed by the formation of the atria more caudally. The further bending results in the atria to assume the more cranial and dorsal position and remodelling of inner curvature brings the outflow and inflow positions of the heart into proper alignment.

Atrio ventricular canal

⇩

Division by the Av septum

⇩

Rt.Av canal& lt Av canal

Aligned with ⇩

Rt.ventricle and Lt.vent ricle respectively.

Conotruncal septation(21)

⇩

1.aorta

2.pulmonary trunk

.

Right - Left asymmetry in the heart

Cardiac looping is the first important milestone in the bilateral symmetry of the embryo. The right left patterning results in the asymmetry of heart, liver, lungs, spleen, gut during period of gastrulation before the organ are formed(22). The word situs solitus implies the usual arrangement of the above said asymmetry organs and situs inversus implies that the mirror image. any process that results in defects in right/left asymmetry are associated with cardiac alignment defects(23).

Robust nodal expressions exclusively in the left sided tissues is promoted by transforming growth factor-b. Normal laterality is decided by the left side expression of the nodal. Kartagener syndrome results from the loss of function of proteins in the ciliary apparutus and it is associated with situs inversus in 50% of cases.

Cardiac chamber development

The ballooning model tells that site of active chamber growth is the outer curvature of looping heart tube while inner curvature remodels in such a way that to align the outflow tract, av canal, and inflow tract in the nascent chambers. The chamber gene expression is induced by NKx2.5, GATA4 and Tbx5.(24)

Ventricular development

The Lt. ventricle is derived mostly from the 1st heart field& the Rt.ventricle is derived mostly from the 2nd heart field(25). Left ventricular development is controlled by transcription factors in the primitive heart tube including NKx2.5, Hand 1, Tbx5. In contrary to that, the transcription factors regulating the 2nd heart field are required for the right ventricle formation(26). The hypoplasia of either left or right ventricle in the severe congenital heart diseases that primary affect one chamber of the heart. For example, mutation of NKx2.5 found in the group of patients in the hypoplastic left heart syndrome. there are case reports showing that patients of hypoplastic left heart syndrome also have the Holt -Oram syndrome. Holt Oram syndrome is associated with mutation in Tbx5.

Atrial development

Orphan nuclear receptor and coup-TF play role in the development of the atrium. . Tbx5 is expressed in caudal portion of heart tube and Tbx5 null mice had severe hypoplastic atria.

MYOCARDIAL GROWTH

It is the complete process that involves the signal coordination from 1.epicardial,2. myocardial and 3.endocardial layers of developing heart. By the end of 4^{th} week of gestation, primitive trabecular ridges seen in the chamber outgrowths along the outer curvature of heart loop. In the course of time the ridges become spongy, fenestrated sheaths that growing into the chamber in the centripetal fashion. These trabeculations effectively increase the myocardial oxygenation surface area in the absence of

coronary circulation(27, 28). Cardiac trabeculations is highly dependent on myocardial- endocardial interactions involving signal proteins. When the coronary vasculature develops and invades the condensed layer of epicardium, the compact layer thickness increases due to compaction of cell proliferation and trabeculation. Failure of the compaction of the trabecular layer results in the spongy myocardium.

AORTIC ARCH AND CONOTRUNCAL DEVELOPMENT

Cardiac defects involving

1. Outflow tract,

2. Aortic arch and

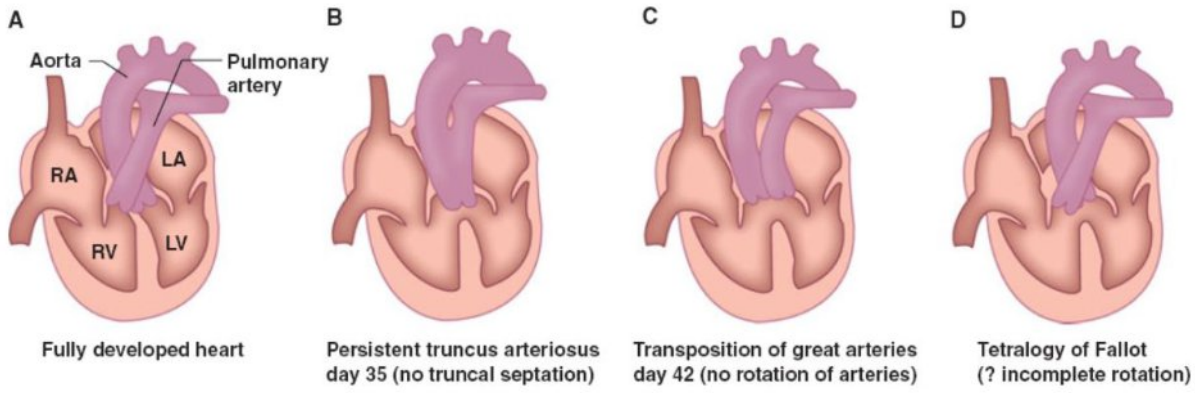
3. Ductus arteriosus constitutes the 21% to 30% of all congenital heart diseases. This region undergoes changes that involves the complex interaction between migrating neural crest cells, second heart field and surrounding pharyngeal tissue.

conotruncal formation

Conotruncus that includes the muscular conus and truncus arteriosus,.(29) . The conotruncal septum septates the truncus arteriosus into the aorta and pulmonary artery. In this stage,

Aorta →communicates with the Rt.ventricle and

Pulmonary artery→ communicates with the Lt.ventricle. Subsequently these two vessels rotates in the spiral fashion to place the aorta more posteriorly and left wards, and the pulmonary artery more anteriorly and right wards. These events leads to the normal alignment of aorta and pulmonary artery with left and right ventricles respectively.



Cardiac defects involving conotruncal development

1.Failure of the septations →persistence truncus arteriosus.

2. If septation happened but failure of rotation →TGA.

3.Partial but incomplete rotation → double outlet right ventricle.

4. In tetralogy of fallot , ventricular septal defect arises because of the failure of connection of conotruncal septum with the muscular septum.The outflow tract is derived from 2nd heart field progenitors added to heart tube and these progenitors gives rise to smooth muscle of truncus arteriosus and outflow tract myocardium.(30)

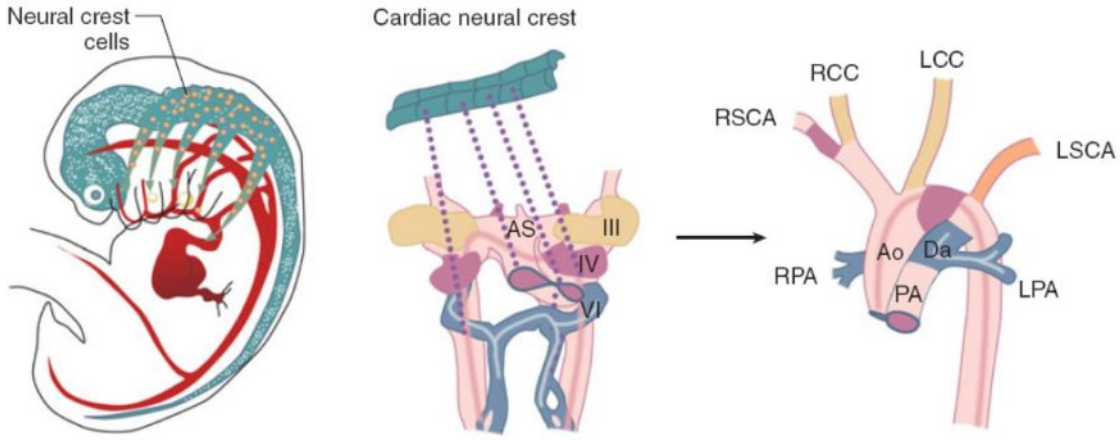
ROLE OF NEURAL CREST IN THE CONOTRUNCAL DEVELOPMENT :

Neural crest cells are the multipotent cells begins to differentiate into cells gives rise to 1. peripheral nervous system,

2.cranial ganglion,

3. adrenal glands, and

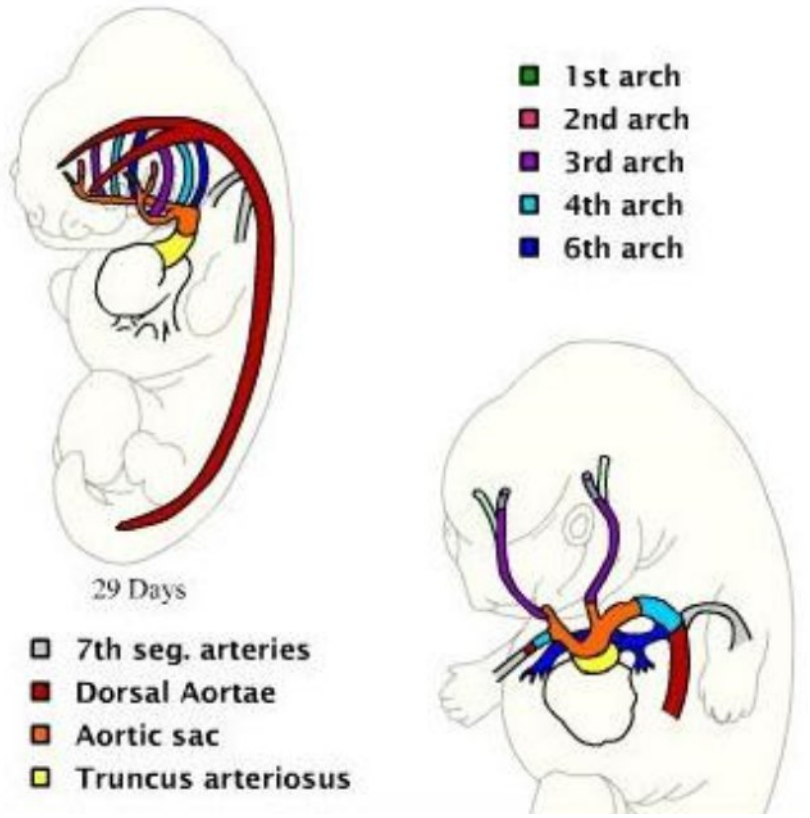
4. melonocytes(29).



Migration and contribution of the cardiac neural crest

The characteristic disorder of neural crest migration is deletion 22q 11 syndrome(31, 32). phenotype feature include thymic, parathyroid, craniofacial, renal and cardiac anomalies.

AORTIC ARCH PATTERNING



Aortic Arch Vessels Development (Day 29 to Week 7)

Vessels	Left	Right
1st arch	Regress - Part of Maxillary artery	
2nd arch	Regress-Stapedial a.	
3rd arch	L/R common, internal, and external carotid aa.	
4th arch	Part of Aortic Arch	Part of rt subclavian a.
6th arch	Left Pulmonary a. Ductus Arteriosus	Right Pulmonary a.
7th seg. a.	Left subclavian a.	Part of rt subclavian a.
Dorsal aorta	Descending thoracic aorta	Regress Part of rt subclavian a.

(33).

CARDIAC CONDUCTION SYSTEM DEVELOPMENT

After the cardiac looping process, a part of the myocardium of inflow tract and Av canal has earlier formed myocardial pattern with high automaticity and slow conduction. The myocytes of this region eventually forms the SA node an AV node(34). The crest of the interventricular septum gives rise to the his bundle while early ventricular chamber myocardium gives rise to the Rt. and Lt. bundle branches and purkinje fibres. The heart tube polarisation takes place along with cranio caudal axis with the dominant pacemaking activity founded the inflow tract. This is the first element to function in the conducting system that gives rise to the dominant SA node. After the looping of the heart the caudal to the cranial depolarisation sequence transformed to base to apex sequence(35). The expression of Tbx3 is found in the SA node precursors. Atrial myocyte phenotype occurs when the repression of the expression of the Tbx3. The ventricular conduction pathway involves the participation of the transcription factors NKx2.5, Tbx5 and Ib2. For example mutation in the Tbx5 gene results in the AV nodal conduction disturbance in patients with holt- oram syndrome

FETAL CARDIOVASCULAR PHYSIOLOGY

IMPORTANT FACTS

There are four important facts in fetal cardiovascular physiology

1. Only one ventricle is adequate for cardiovascular stability in the fetus. Although the separate function of two ventricle in the normal fetus in the conditions of absence of one ventricle in most instances is capable of taking over the function of other ventricle in order to achieve the stable hemodynamic status in the fetus(36).

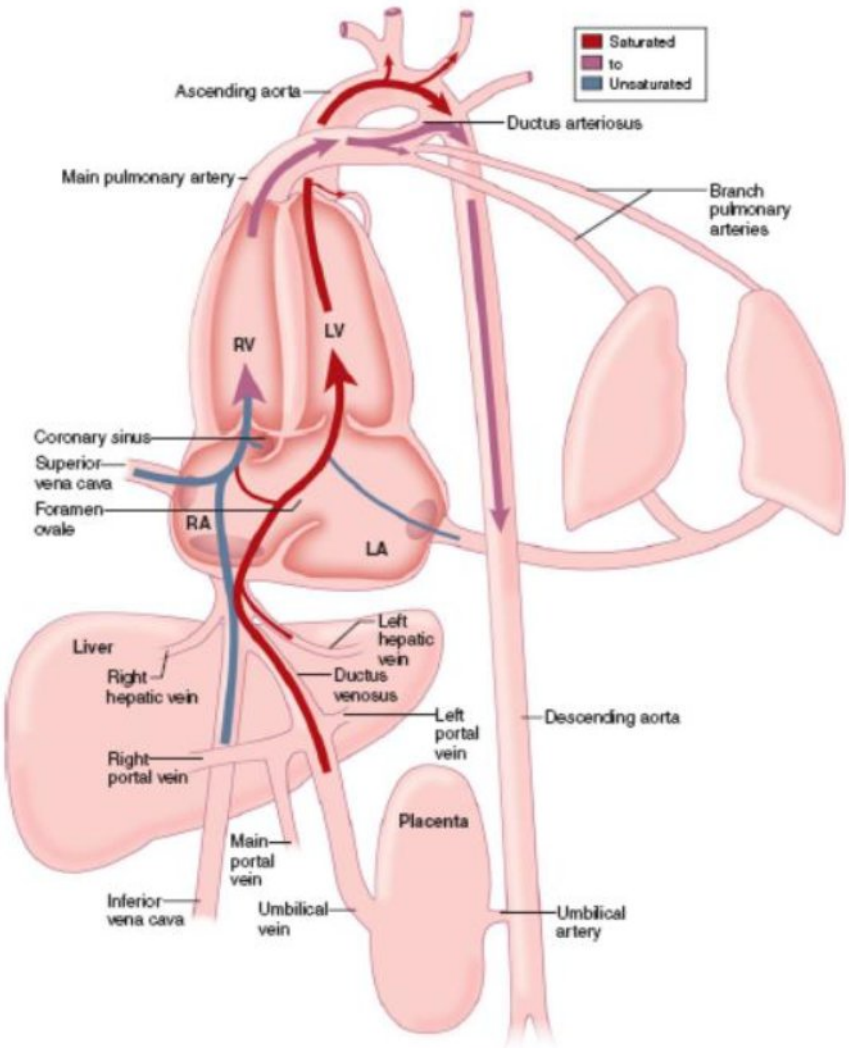
2. The right and left ventricle do the similar function in the fetus as parallel with the ventricle is divide the work of ejecting the blood of similar content of oxygen for uptake and delivery while in the postnatal period the circulation is in the series with the left ventricle ejecting highly oxygenated blood to high metabolic organs while the right ventricle ejecting poorly oxygenated blood for the oxygen uptake to the lungs(36).

3. The dominant ventricle in the fetus is the right ventricle not the left. In the postnatal period the left ventricle ejects the same amount of blood as the right ventricle but at higher pressure so the left ventricle becomes the dominant ventricle in the postnatal period. In the normal fetus the Rt.ventricle ejects more blood than the Lt. ventricle but at the same pressure so the right ventricle becomes dominant(37).

4. The orientation, projection , size of the cardiovascular structures after the period of embryogenesis is determined by volume of blood passing through it and by the floe pattern.

FUNCTIONS OF FETAL VENTRICLES

In the fetal period, the central shunts between the major vascular beds namely systemic, pulmonary, placental circulation and two side of the heart(38). The ductus venosus connects the placental venous return to the systemic venous return, ductus arteriosum joins the systemic arterial circulation to the pulmonary arterial circulation and the right and left side of the heart connected by the patent foramen ovale. The blood flow pattern in the fetus allows the poor oxygenated blood to the right ventricle directing towards the placenta of uptake of oxygen while good oxygenated blood to the left ventricle for the delivery of oxygen to the high metabolic organs(39).



Fetal circulation

There are 6 parts in the fetal central venous system(36)

1. Superior vena cava- the channel which receives upper body blood flow

2. Inferior vena cava- receives lower body blood flow

3. Coronary sinus- receives cardiac venous return

4. Ductus venosus - placental blood flow from the umblical vein drains into this

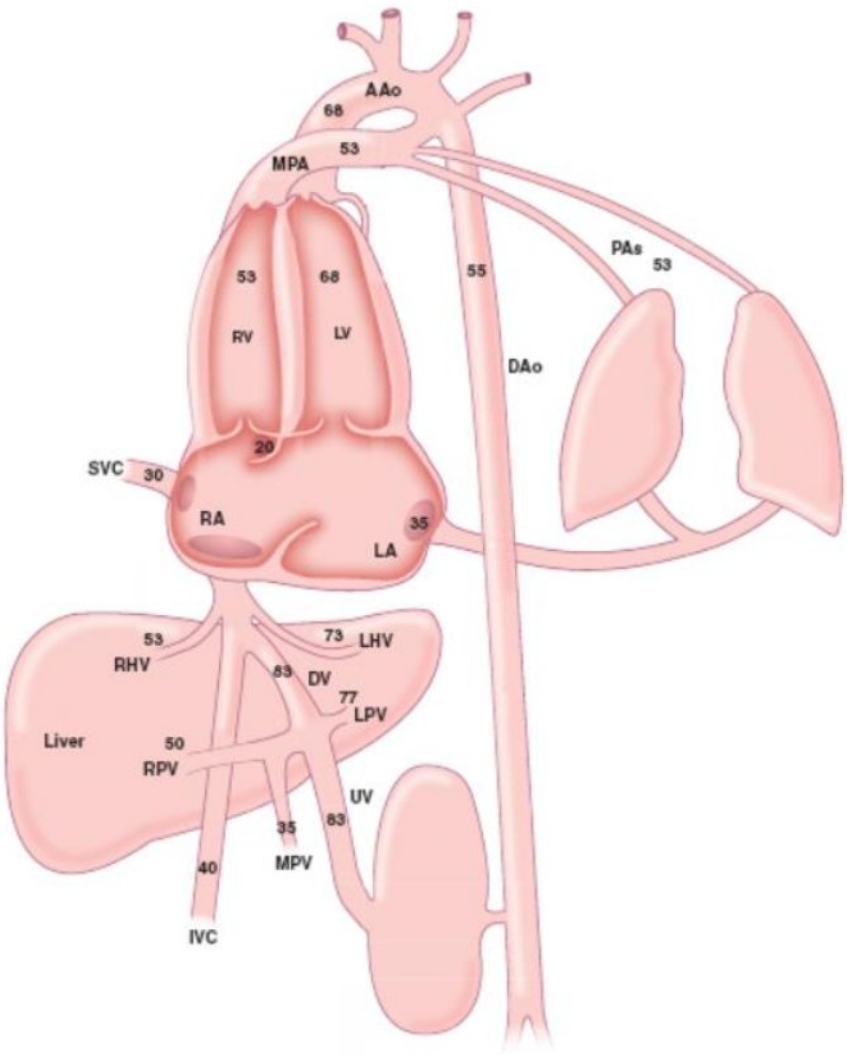
5. Hepatic vein - receives hepatic arterial flow and portal venous flow

6. Pulmonary vein - receives the blood flow of pulmonary circulation.

The majority of the blood in the coronary sinus and the svc drains into the rt. atrium and then to rt.ventricle. The eustachian valve guarding the sinus venosus helps in the crossing of the blood across the tricuspid valve in to the right ventricle. The coronary sinus drains the blood into the right atrium directs the stream of blood across the tricuspid valve into the rt. ventricle. The svc which drains the blood from the brain and the upper extremities is poorly oxygenated. The coronary sinus draining from the myocardium is the most desaturated blood so the poorly oxygenated blood from the venous system drains into the right ventricle(40). The inferior vena cava (lower) connects with the right and left hepatic veins and the ductus venosus to form the IVC upper part. The upper IVC is short and the shows the fascinating pattern of streams, this patterns are required for the effective split of venous system to the two ventricles. The lower IVC blood is not much desaturated then compared to the coronary sinus and upper body. The coronary sinus blood is the most desaturated blood. The blood flow in the upper IVC , lateral wall is separated from the other sources of venous blood except right hepatic veins which enters at the level of upper IVC. The blood from right hepatic arteries and splanchnic circulation

drains into the right hepatic veins. The right hepatic vein and the lower body venous stream joins and travel the inferior margin of the eustachian valve directing into the rt. atrium and further into the rt. ventricle. The course of umbilical blood in the upper IVC is different. Umbilical vein enters into the portal sinus from this point the umbilical blood flow divided into left portal stream and ductus venosus. Ductus venosus blood is highly saturated because it is coming from the umbilical vein. Blood in the left portal vein joins with hepatic arterial flow in the liver to exit as the left hepatic vein. Blood coming from the left hepatic vein and ductus venosus enters into the medial margin of upper IVC. the two oxygenated streams of the blood travels into the right atrium n the way along the superior margin of eustachian valve and directed towards the foramen ovale atlast the blood of the pulmonary vein drains into the lt. atrium directly.

As the result of this patterns of circulation the left ventricle receives blood from the lt.hepatic vein, ductus venosus, and saturated umbilical venous blood. The rt. ventricle receives blood of lower oxygen saturation .The oxygen saturation difference between the rt and lt. ventricle is approximately 20%. The high metabolic organs in the fetus are brain, heart, and adrenal glands. Inspite of adrenal gland consumes much oxygen per gram of tissue it receives the only very small amount of blood flow.



Hemoglobin oxygen saturation in central blood vessels and cardiac chambers

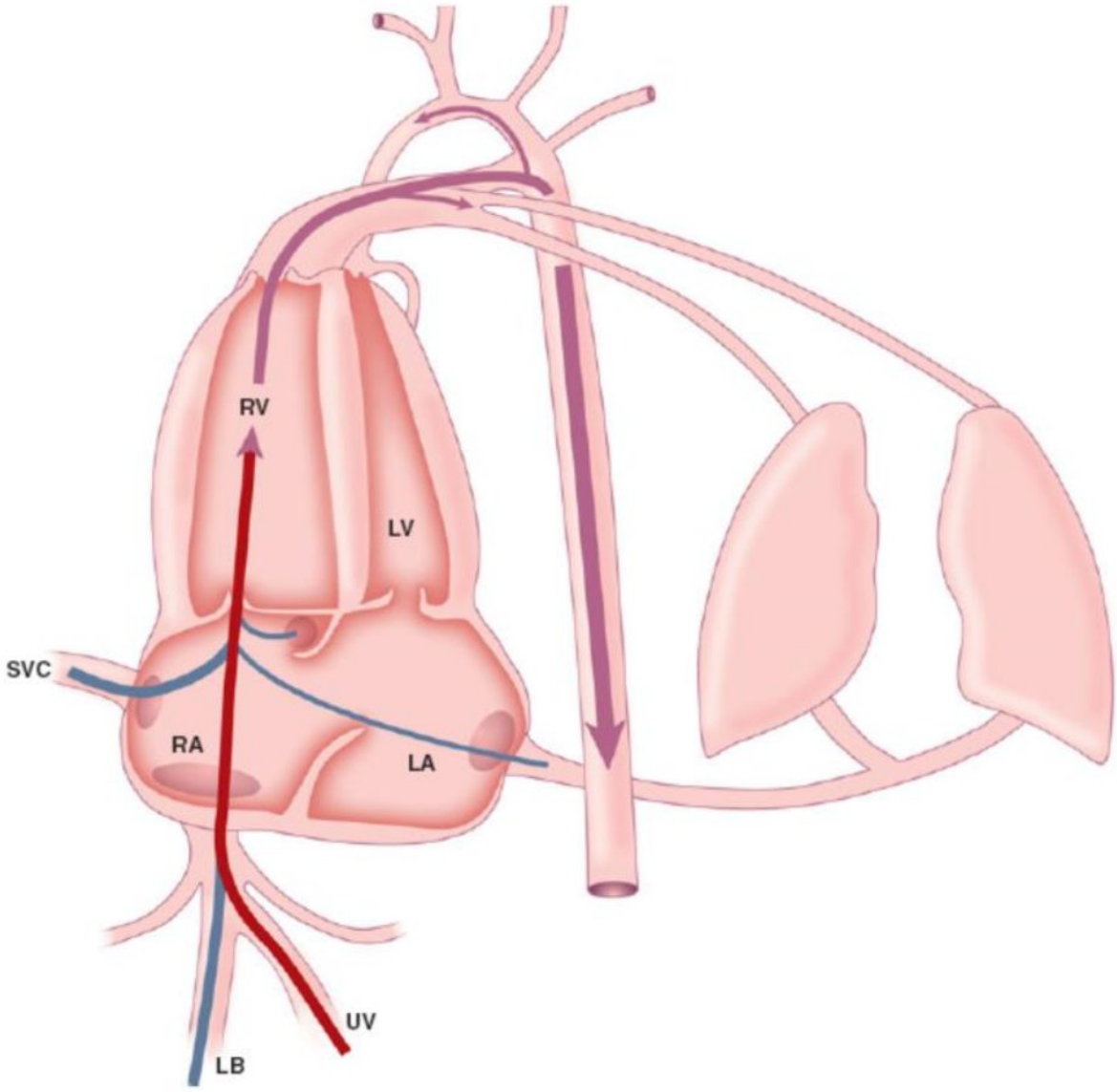
The brain and heart receives blood from the left ventricle. Nearly 7% of LV output is delivered via coronary arteries to the heart and 55% is delivered to the brain. Of the remaining LV output, 23% is delivered to the descending aorta and 15% is delivered to upper extremities. Only the small portion of the LV output joins with the right

ventricle into the descending aorta. In contrary to that descending aorta receives much blood from the right ventricle. In the fetal period the resistance to the pulmonary vascular blood is so high. So very small amount of fetal rt. ventricular output is delivered to the lung. The remaining blood crosses the ductus arteriosus to pass into the descending aorta. So the right ventricular desaturated blood is goes to the placenta for o2 uptake others go to the low metabolic organs. The majority of the left ventricle output of saturated flow is delivered to the metabolic heart and brain. In the fetal period although the lower oxygenation of blood delivered to the body of fetus of which only 30% of o2 is extracted leaving the fetus almost same amount of oxygen extraction reserve.

SINGLE VENTRICLE MAINTAINED CARDIOVASCULAR STABILITY

Only single ventricle is necessary for cardiac stability because the central shunts allows the ejection of blood into three vascular beds.

Hypoplastic left heart syndrome-univentricular physiology



For example in hypoplastic lt. heart syndrome all the venous blood except from the pulmonary circulation (smaller amount) enter into the rt. atrium in the normal fashion(41). The blood in the ductus venosus and blood in the left hepatic vein crosses along with rest of systemic venous blood across the tricuspid valve- rather than crossing to lt. atrium through the foramen ovale. The pulmonary venous blood crosses the ovale foramen and enters into the right ventricle instead of crossing the

mitral valve. So the right ventricle is the chamber receiving all the venous blood. Of the right ventricular ejected blood only 8% is entered into the main pulmonary artery and 92% is crosses the ductus arteriosus into the descending aorta since there is the atresia of the aortic valve also. So, blood from ductus arteriosus not only passing to the descending aorta but also travels in the retrograde fashion to supply the aortic arch. Thus blood flow to the all body parts and fetus grows normally.

RIGHT VENTRICULAR DOMINANCE

In the fetus the systolic pressure is same in two ventricles because they eject into almost similar vascular beds. But the fetal ventricles differs in the volume of ejection of blood. The right ventricular ejection constitute the 55% of the total cardiac output. The right ventricular mass is greater than the left ventricular mass and the systolic and diastolic contraction are reversal. fetal right ventricle has the capacity to constrain the left ventricle filling and so thus the dominant ventricle(42). This constraint place the huge role in the under development of the lt. ventricle of the fetus the condition such as total anamalous pulmonary venous connection. In the Coarctation of aorta the rt. ventricle is more dominant because the more blood crosses the ductus from the right ventricle than from the left ventricle(43, 44). So that the load increase the right ventricle constraint.

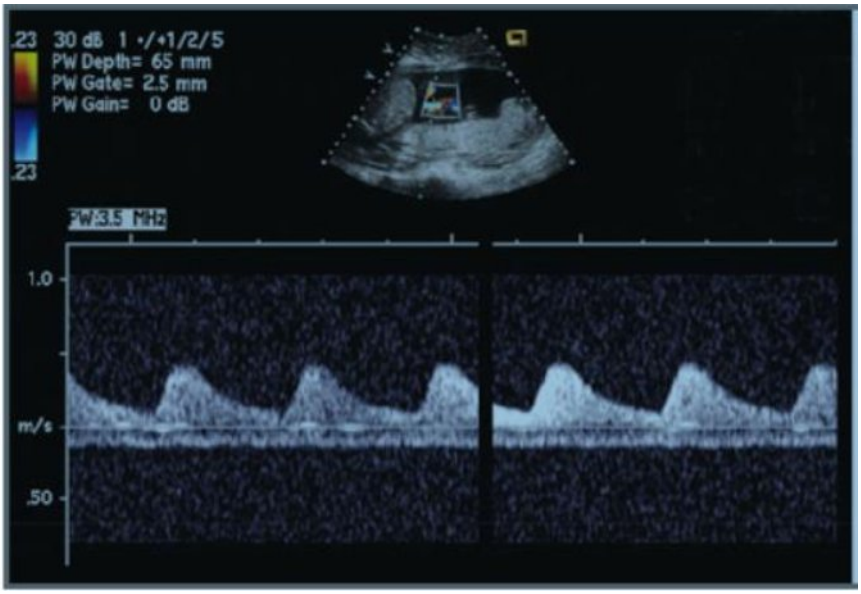
EFFECTS OF BLOOD FLOW ON CARDIAC STRUCTURE

Normally one third of venous blood passes from rt. atrium to the lt. atrium through the foramen ovale. In the hypoplastic lt. heart syndrome the aortic valve atresia limits the blood flow across the mitral valve so that the mitral valve and the left ventricle do not develop normally. The obstruction in the forward flow acts like a hurdle to the flow of blood from rt. to lt. via the foramen ovale. So the foramen ovale can be small or abnormal configuration the large increase in the left atrial venous return in the postnatal period should cross the small foramen ovale which results in the obstruction of pulmonary venous drainage and it is associated with increase in lt. atrial pressure and pulmonary edema. Because of the ascending aorta and aortic arch receives the blood in the retrograde fashion via the ductus arteriosus, there is diversion of blood stream one passing superiorly and another passing inferiorly so there is the formation of shelf descending aorta and aortic isthmus(45, 46).

HEMODYANAMIC STABILITY EVALUATION

Hypoxemia, retardation of the growth and decreased ventricular output gives rise to increased resistance to the lower body and the placental beds on the arterial side. This proved by the greater reduction in the end diastolic velocity than the reduction in the systolic velocity of the umbilical artery and descending aorta leading to the increased pulsatility(47).

Umbilical arterial blood flow patterns by Doppler ultrasonography in normal



Normal pattern with forward flow throughout systole and diastole.

Pulsatility index = S - D/ M

where S is the peak systolic velocity

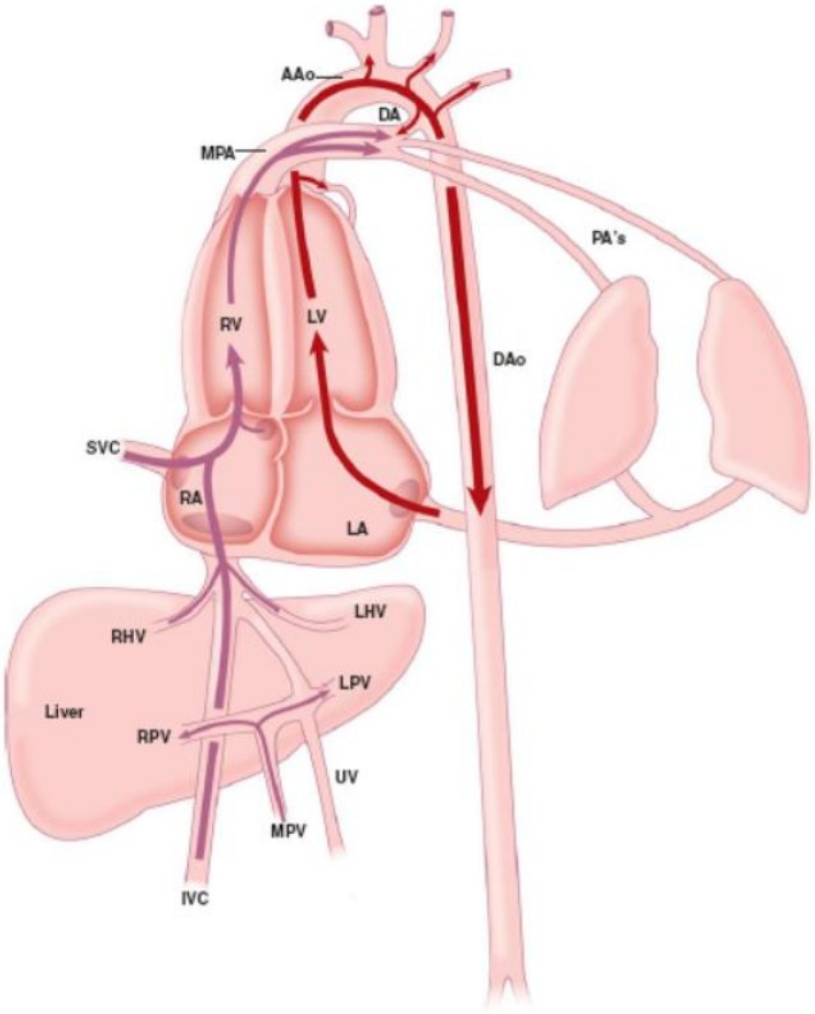
D is the end diastolic velocity

M is the mean velocity (48)

On contrary end diastolic velocity is increased in the myocardial and cerebral circulation results in the lower pulsatility index. This shows the brain and heart sparing metabolic effects.

In the venous side,the blood flow pattern change when the heart begins to fail and during the increase in the preload. The veins analyzed in this are umbilical vein, ductus venosus, inferior vena cava.

TRANSITIONAL CIRCULATION



After birth, major changes occur in the blood flow pattern and the cardiovascular function as the process of adaption to the new environment. Three important adaptions are

1. Both ventricular output increases to the maximum to meet the energy expenditure for the thermoregulation and the work of breathing.

2. Pulmonary blood flow increases to the major amount- 20 times when compared to the pulmonary circulation in the fetus.

3. Alteration in the central blood flow pattern

The abolition of central shunts and alteration in the blood flow ,converts the circulation in parallel to the circulation in series.

INCREASED COMBINED VENTRICULAR OUTPUT

In the fetal period arterial oxygen in systemic level is low 20-25 torr. But the oxygen demand is low and also the shift of the dissociation curve to the left. Birth is the process associated with the increase in the metabolic requirement. Work of breathing uses 30% of oxygen consumed by the newborn. Thermoregulation also consumes the major oxygen. So the rate of oxygen consumption triples after birth.

The lt. ventricle, before birth supplies oxygen to the upper body, brain, heart ,now has to supply the whole body. So the lt. ventricular output increases three times in the way of increasing heart rate and the stroke volume.

INCREASE IN THE PULMONARY CIRCULATION

Major changes in the pulmonary circulation occur in the first few minutes after birth. Further changes are subtle and gradual over the several weeks after birth. After the few breaths the pulmonary blood flow increases upto 20 times when compared to the fetal levels. Though oxygen is the great pulmonary vasodilator, ventilation with low concentration oxygen has the capability of decreasing pulmonary vascular resistance to 2/3rd and increase in the pulmonary blood flow. The decrease in the pulmonary vascular resistance caused by the ventilation and changes in the alveolar air liquid interface surface tension. The decrease in the p.v.r attains the matured level within 2 months after birth(49).

CENTRAL BLOOD FLOW PATTERN CHANGES

Changes in the blood flow pattern occurs because of the abolition of the central shunts and thereby converting the circulation in parallel to the circulation in series. Umbilical arterial flow stops immediately after birth during the clamping of the umbilical cord. As the umbilical venous flow ceases the ductus venous flow

also decreases but the closure of ductus venosus takes several hours or days after birth. The flow through the foramen ovale and ductus arteriosus is abolished by a large increase in the pulmonary blood flow (by decreasing the pulmonary vascular resistance) and by increasing the oxygen tension in the systemic circulation(50). In the fetal heart rt to lt shunt occurs through the foramen ovule through which 1/3rd of venous return enter into the lt. atrium and left ventricle. The floor of the foramen ovale has the flap which bulges into the left atrium. After birth the pulmonary venous blood directly enters into the left atrium thereby the flap is closed because of the increased pressure in the left atrium. The foramen ovule is only functionally closed because of the difference in pressure between the left atrium and the right atrium but when the infant cries the right atria pressure increases thereby the momentary increase in the right to left shunt so there is the transient desideration. After birth the last central shunt closed is ducts arteriosus. The flow through the ductus arteriosus does not stop immediately after birth but occurs through the first 48 hours of life. Oxygen initiates the closure of ductus arteriosus and the other factors involved are bradykinins, arachidonic acid and catecholamines(51).

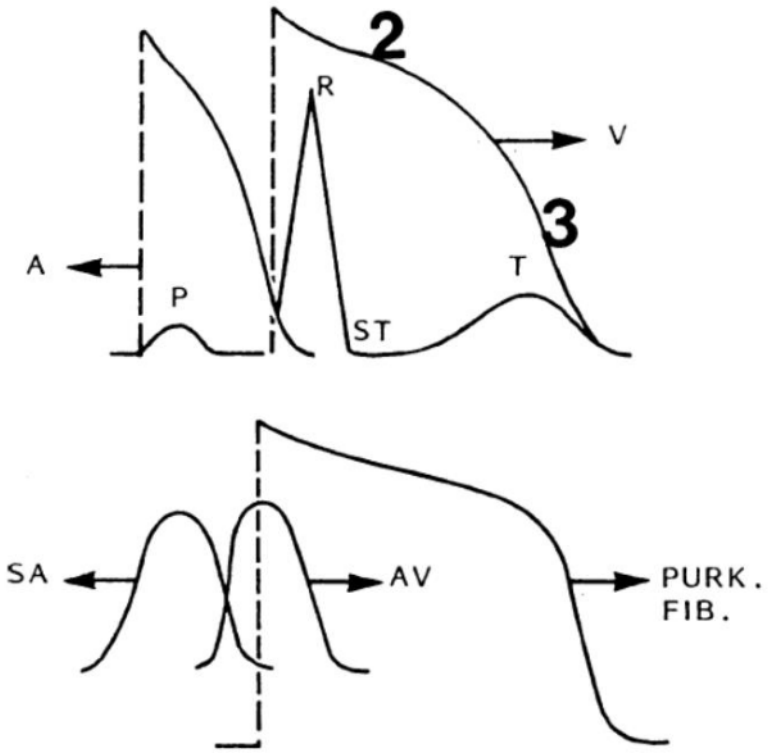
ELECTROCARDIOGRAM

The waveform of the ecg recorded from the body depends on the

1.conducting tissue interposed between heart and the electrode,

2. action potential and

3. propagation.



ECG AND ACTION POTENTIALS

MANIFEST: ATRIUM(A), VENTRICLE(V)
CONCEALED: SA NODE, AV NODE, PURK. FIB.

Timing of cardiac action potentials recorded during inscription of an ECG complex. The action potentials responsible for the atrial and ventricular activation are designated *manifest* and those responsible for impulse initiation and propagation as *concealed*.

Atrial depolarisation gives rise to the p wave. Ventricular depolarisation gives rise to the QRS complex, the phase 2 of the action potential gives rise to the ST segment and phase 3 of the action potential gives rise to the p wave.

DEPOLARIZATION AND REPOLARIZATION

Depolarization: Cell

⇩

Electrical impulse generation

⇩

ions move across cell membrane

⇩

generation of action potential

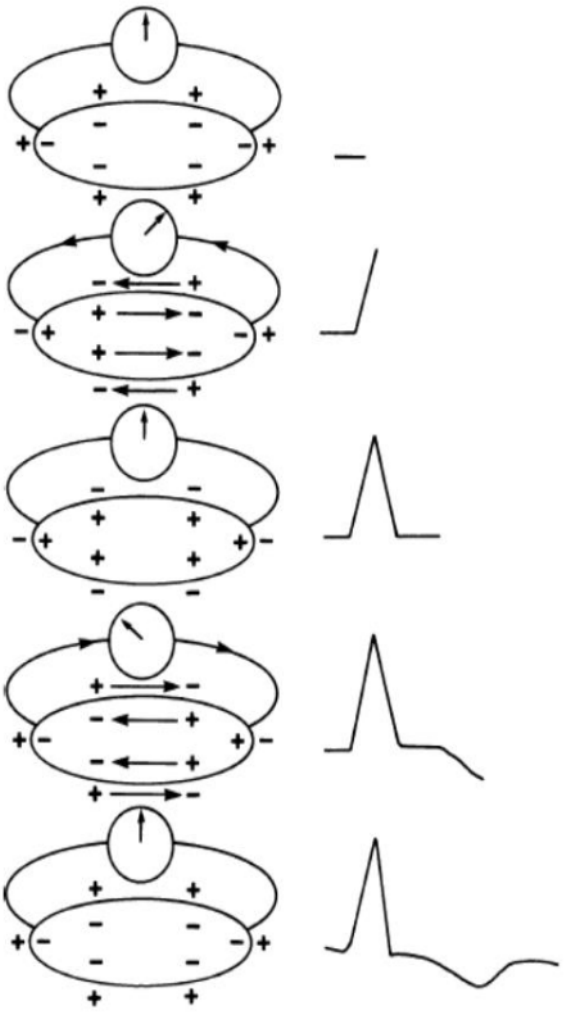
⇩

contraction of cardiac muscle .

Repolarization: ions return to resting state

⇩

Relaxation of cardiac muscle.

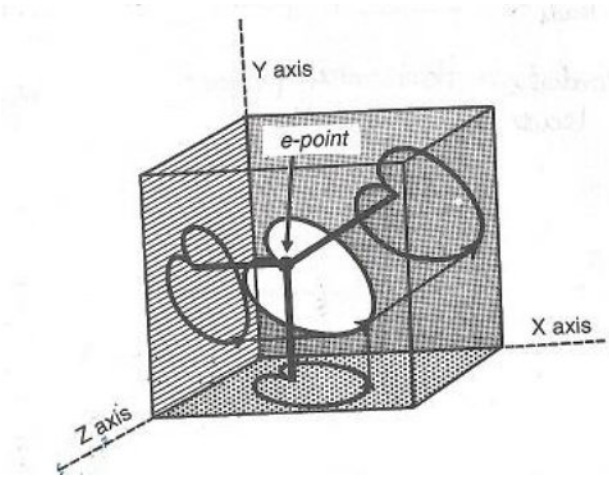


Resting state, depolarization, and repolarization in a single cell, the two ends of which are connected to a galvanometer. On the right are ECG deflections resulting from the polarization changes in the diagram on the left.

VECTOCARDIOGRAPHY VERSUS SCALAR ELECROCARDIOGRAPHY

Vectocardiogram is the recording of the magnitude and the direction of the electrical force.Cardiac cycle creates the three dimensional loop comprising of

small P loop,large QRS loop,medium T loop,all of these starts and ends at the e point



. In the VCG,3D loops of the vector are projected into the three perpendicular coordinates X,Y,Z.X axis denotes right or left, Y axis denotes up or down,Z axis denotes anterior or the posterior.

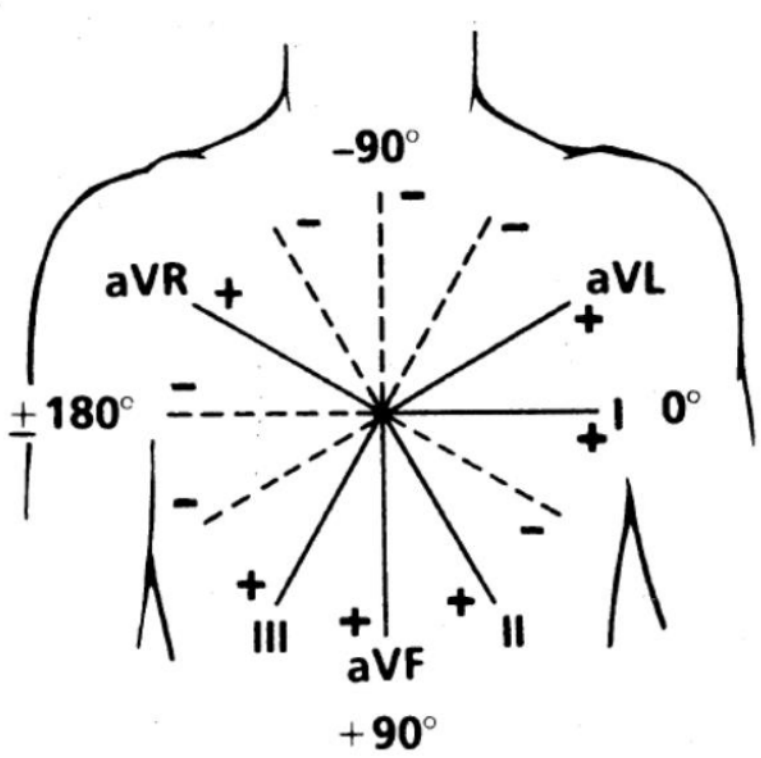
Scalar is the one with the magnitude only.Scalar ecg is the ordinary ecg that is used in the clinical practice with the magnitude only.

VECTORIAL APPROACH

This translates the two or more scalar ecg with the magnitude only to electrical force with both the magnitude and the direction.magnitude is represented by the height of the the wave and the frontal&horizontal projection of the leads represents

the direction of the forces. Limb leads gives the information regarding the frontal projection while the precordial leads gives information of the horizontal plane.

Hexaxial reference system



It consists of six limb leads and gives information about the frontal orientation of electrical forces. In this system lead I and lead aVF are perpendicular to each other at the electrical centre. Each leads positive limb is shown as the solid line and each leads negative limb is shown as the dotted line. The limb leads lead I, lead II and lead III are oriented in the clockwise manner with 60 degree.

Lead	**Oriented towards**
aVR positive pole →	Right shoulder
aVL positive pole →	Left shoulder
aVF positive pole →	Foot

Lead	**positive pole** (degree)	**negative pole** (degree)
Lead I	0	+/- 180
Lead II	60	-120
Lead aVF	90	-90
Lead III	120	-60
Lead aVR	-150	+30
Lead aVL	- 30	+150

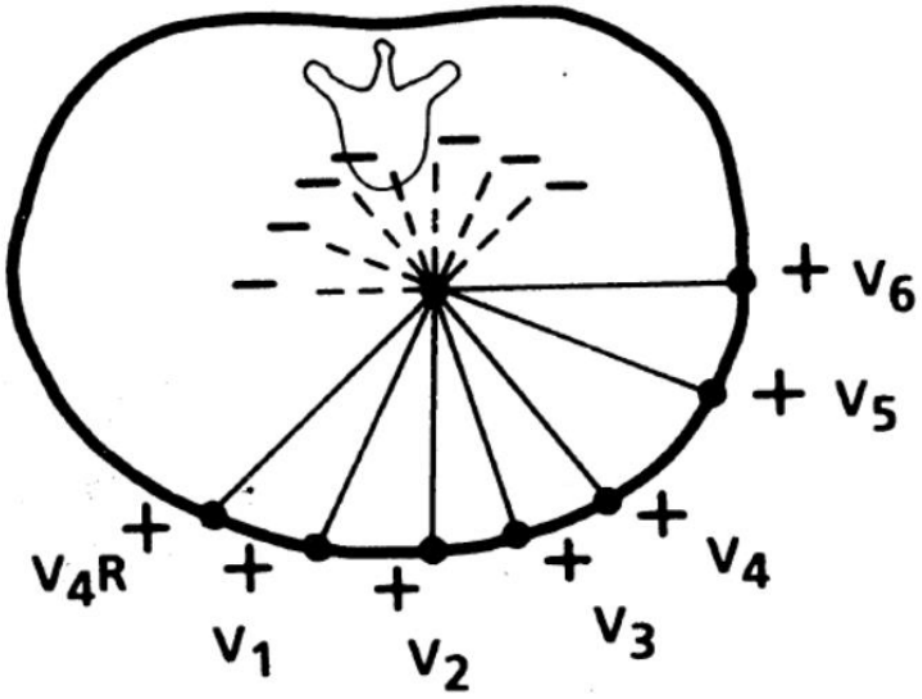
The axis of lead I tells about the right left relationship. Its positive pole lies on the left side and negative pole lies on the right side.

The axis of lead aVF tells about the superior inferior relationship. Its positive pole is oriented inferiorly and its negative pole is oriented superiorly.

The Q and S wave represents the force of depolarisation oriented towards negative pole. The R wave represents the force of depolarisation oriented towards positive pole.

'R' wave in lead I	→	Leftward force
'S' wave in lead I	→	Rightward force
'R' wave in aVF	→	Inferior force
'S' wave in aVF	→	Superior force
'R' wave in lead II	→	Leftward and inferior force
'R' wave in lead III	→	Rightward and inferior force
'R' wave in aVR	→	Rightward and superior force
'R' wave in aVL	→	Leftward and superior force

HORIZONTAL REFERENCE SYSTEM



This tells about the right left relationship and anteroposterior relationship. It consists of precordial leads. Its positive limb is shown as the solid line and the negative limb is shown as the dotted line. The lead V2 and the lead V6 are 90 degree to each other at the centre of the heart. The lead V2 tells about the anteroposterior relation. Its positive pole is projected anteriorly and its negative pole is projected posteriorly. The lead V6 tells about the right left relationship. Its negative pole is projected to right side and its positive pole is projected to left side. The lead V3 R and V4 R are the mirror images of the leads V3 and V4 which are the corresponding right sided leads.

‘R’ wave in V2 -> Anterior force

‘S’ wave in V2 -> Posterior force

‘R’ wave in V6 -> Leftward force

‘S’ wave in V6 -> Right ward force

‘R’ wave in V1 -> Rightward and anterior force

‘S’ wave in V1 -> Leftward and posterior force

‘R’ wave in V5 -> Leftward force

‘R’ wave in V3, V4 -> Transition between right and left precordial leads

S wave in V2 tells about the posterior orientation of electric forces and thus LV forces. But in cases of extreme right axis deviation, S wave in V2 shows the RV force which is projected rightward and posteriorly.

NORMAL QRS LOOP VECTORCARDIOGRAPHY

In the normal newborns frontal plane of vectorcardiogram, the QRS vector is oriented to subjects right & inferiorly, direction of QRS loop is in the clockwise direction. This shows that the dominant ventricle in the new born period is the right

ventricle. But in the older children & adults the orientation of the QRS vector is left & inferior and maintains the clockwise loop. When the new born growing up, there will be shift of QRS vector from right lower quadrant to the left lower quadrant with no changes in the inscription direction. This shows that dominance of ventricle is shifted from right to the left side.

In the vectorcardiogram horizontal plane newborn QRS loop is in the anterior & right quadrant (RVdominance) and inscription - clockwise.

In the adults the loop is in the posterior and left quadrant (LV dominance) and inscription - counter clockwise. This the reason for the rsR' and notched R or S seen in the lead V1 of new born ecg.

CARDIAC ELECTROPHYSIOLOGY

Each cardiac circle is represented by

1. ‘P’ wave

2. ‘QRS’ complex

3. ‘T’ wave

4. ‘PR’ interval

5. ‘QT’ interval

6. ‘PQ’ segment

7. ‘ST’ segment

During the normal sinus rhythm, the sino-atrial node is the dominant pacemaker of the heart.

The SA node

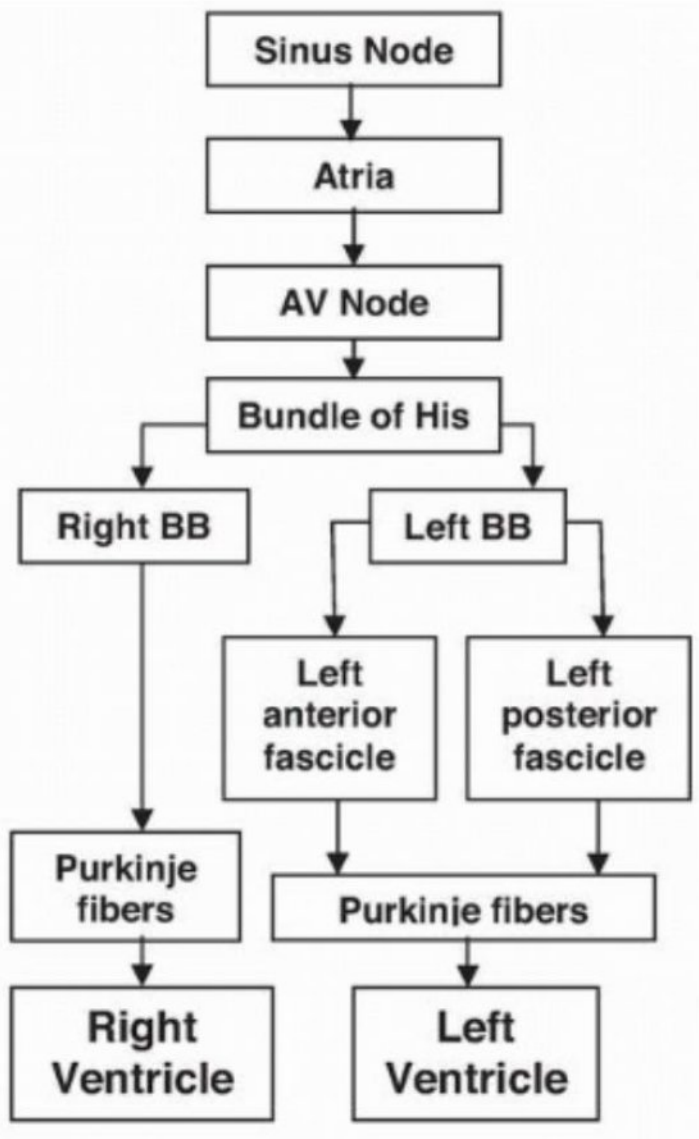
|

Depolarisation of right and left atrium

|

P wave

When the impulse arrives at the atrioventricular node it moves through the node slowly creating the PQ segment.



Once the impulse arrives at the bundle of His, its velocity attains the faster level and it spreads through the rt. and lt. bundle branches through purkinjee fibres to ventricular muscle, thereby produces the direct QRS complex. The ventricular repolarisation is represented by T wave. But the atria repolarisation is usually not shown in the ecg.

P wave -> Atrial depolarisation

QRS wave -> Ventricular depolarisation

T wave -> Ventricular repolarisation

PR interval -> P wave duration +

PQsegment

QT interval -> QRS duration +

STsegment + T wave duration

MEASUREMENTS

In the normal ecg the speed of the ecg paper is 25mm / second(5). So

1mm = 0.04 sec

5mm = 0.20 sec (one large division)

30mm = 1.3 sec (six large divisions)

P WAVE DURATION

It is measured from the onset of ‘ P’ wave to the end of ‘ P’ wave. This duration is prolonged in left atria hypertrophy**.**

‘PR’ INTERVAL

It is measured from beginning of the P wave to onset of QRS complex. And so it is sometimes called as PQ intrerval. It represents the normal conduction to the AV node. The PR interval is usually measured in the lead II with visible Q waves. In the leads that are perpendicular to the septal depolarisation of the ventricles the Q waves may be absent or isoelectric. This produces the falsely prolonged PR interval.

QRS DURATION

It is measures from onset of ‘Q’ wave to end of the ‘S’ wave. It can be measured in the chest leads as long as QRS deflections are small. Usually the QRS in lead V2 to V4 is large and QRS duration can be falsely prolonged. The QRS can be prolonged in intraventricular block bundle branch blocks and during the preexcitation.

QT INTERVAL

It is measured from the beginning of the Q wave to the end of the T wave. The prolonged QT interval can predispose the individual to serious ventricular arrhythmias.

JT INTERVAL

It is measured from J point (the junction between the S wave and ST segment). The JT interval is measured only during the QRS duration prolongation at the QT interval prolongation.

CALCULATION OF THE AMPLITUDE

We usually measure the amplitudes of P wave QRS complex and T wave.

Amplitude of P wave -> Right atrial hypertrophy

Amplitude of QRS complex -> Ventricular hypertrophy

Amplitude of T wave -> Myocardial disorders,

Electrolyte abnormalities,

Ventricular hypertrophy.

CALIBRATION FACTOR

The gain of the amplifier is made in such a way that when a millivolt signal introduced in a circuit it produces the 10mm deflection in the ecg(5). It is usually located at the left or right end of the trace. One should see the calibration factor before measuring the amplitude of the ecg deflection.

One standardisation -> 10mm

One half standardisation -> 5mm

One fourth standardisation -> 2.5mm

THE R/S RATIO

It is important in diagnosis of right/left ventricle hypertrophy (dominance). It is usually measured in lead V1, V2, V6. It compares the amplitude of R wave to that of S wave.

QRS AXIS

It changes in ventricular conduction disturbances, ventricular hypertrophy, bundle branch blocks. We require only the limb leads to calculate the QRS axis as well as P wave and T wave axis.

It is calculated by the following methods

1. successive approximation method

2. graph method

P WAVE AXIS

We can use the same method used for the calculation of the QRS axis, but the difference is we have to look for the flat P waves if we cannot find the equiphasic P wave. The P wave tells about the vector direction of atrial depolarization and so it tells about the location of the pacemaker site. In the normal individuals (situs solitus) location of the SA node is at the junctional point of SVC and right atrium. It usually lies in the lower left quadrant (0 degree to 90 degree)

T WAVE AXIS

Normal T wave axis is located in the lower left quadrant (0 to 90 degree). T wave vector axis is useful for determining severe ventricular hypertrophy, myocardial disorders and also the conduction disturbances.

THE QRS-T ANGLE

It is the angle between QRS axis & T axis. It tells about the relationship between the depolarisation activity and repolarisation activity of the ventricles. It is useful in the diagnosis of ventricular hypertrophy, myocardial disorders and also the conduction disturbances.

QRS VECTOR - ANTEROPOSTERIOR FORCE

The most useful lead to calculate the anteroposterior force of the QRS vector is the lead V2.

QRS vector		**Direction**
Positive	->	anterior
Negative	->	posterior

TERMINOLOGY OF ECG DEFLECTIONS

Initial downward deflection of QRS complex -> Q wave

Initial upward deflection of QRS complex -> R wave

Negative deflection after the R wave -> S wave

Second upward deflection after S wave -> R' wave

Second downward deflection after R' wave -> S' wave

Single downward deflection without R wave->QScmplx

ECG AGEWISE CHANGES:

This depends on the changes in the left ventricular and the right ventricular mass after birth. At the time of the birth, right ventricle is heavier then the left ventricle. At birth LV/RV ratio is 1.5:1 then at the age of six months, it becomes 2:1. Then the ratio increases very gradually till it reaches the adult value of 2.5 : 1

AGE	**LV/RV RATIO**
G .A 30 weeks	1.2 :1
G.A 33 weeks	1.0:1
G.A 36 weeks	0.8:1
birth	1.5 :1
6 months	2.0 :1
Adult	2.5 :1

The ecg shows these anatomical changes. The RV dominance in new born period is changed to the LV dominance of adult over the years.

The following changes takes place when the age increases:

1. Heart rate starts decreasing

2.’PR’ interval, ‘QRS’ duration, ‘QT’ interval increase

3. Rt. ventricular dominance starts changing to the lt. ventricular dominance

a. ‘R’ wave amplitude in the rt. sided chest leads starts decreasing at the same time ‘R’ wave amplitude in the lt. sided chest leads starts increasing.

b. ‘S’ wave amplitude in the rt.sided chest leads starts increasing while the amplitude of S wave in the lt.sided chest leads starts decreasing

c. The QRS axis moves from anterior- right in infants to the posterior - left in adults

d. R/S ratio in rt. sided precordial eads starts decreasing while in the lt. sided chest leads starts increasing.

e. During 3-8 years of age the children ecg is similar to that of the adult ecg except for T waves in rt. precordial leads.

f. T vector anteriorness in newborn period disappears in few days while the T wave in V1 become inverted by the fourth day of life. In children horizontal plane T wave remains in the posterior direction. After the ten years of age the T vector moves in the anterior direction so that T wave becomes upright in lead V1 and V2.

ECG OF PRETERM INFANTS

In the preterm infants, because of the ductal flow there is more pulmonary venous return thereby increases the lt. ventricular mass. In preterm infants the lungs are immature with alveoli lesser in quantity. This produces the low alveolar oxygen thereby producing the constriction of the pulmonary arterioles. These produces the changes in the lt. ventricle and the rt ventricle respectively so while interrupting the ecg of pre term infants we have. to take the consideration of gestational age and the cardio pulmonary physiology. The QRS and T wave voltages of the preterm infant are usually lesser than that of term infant. The RV dominance is present in the both preterms and term but it is little less for the premature.

THE NORMAL ELECTROCARDIOGRAM IN VARIOUS AGE GROUPS

The new born ecg and the neonatal ecg usually show the RV dominance & right axis deviation. Usually the right ventricular voltage exceeds that of the left ventricular voltage. In between the one month upto three years of age intermediate ecg findings are noted and they usually show the LV dominance. After three years of age, the ecg resembles that of the adult ecg.

NEWBORN

1. In limb leads the QRS voltages are usually small.

2. The QRS axis is rightwardly deviated with the axis upto 180 degree.

3. The chest leads show the RV dominance.

    a. In rt. precordial leads tall R waves are noted.

    b. In lt. precordial leads, deep S waves are seen

    c. The R/S > 1 is seen in rt. precordial leads.

4. Usually the T waves are of low voltages.

5. In the first day of life the T waves are usually upright but within three days of life it usually becomes negative**.**

ONE WEEK TO ONE MONTH

1. Dominant ‘R’ wave is seen in the rt. precordial leads.

2. Right axis deviation persists

3. In V6 R wave is dominant

4. T wave voltage in limb leads becomes slightly higher than that of the newborn period.

5. T wave in V1 is usually negative

6. R/S progression partially reversed with dominant R waves are seen in both right & left precordial leads

ONE MONTH TO SIX MONTHS

1. The QRS axis becomes less than 90 degree but upto 125 degree can be considered as normal

2. In lead V 1 R wave continues to be dominant

3. The R/S ratio in V2 is approximately 1

4. In lead V1 the T wave remains negative

5. Usually biventricular hypertrophy pattern is seen in the midprecordial leads because of larger QRS deflections.

SIX MONTHS TO THREE YEARS

1. The QRS axis < 90 degree

2. R/S ratio in lead V1 approximately comes to 1

3. R/V is usually dominant in V6

4. The R/S progression is more or less similar to that of the adult R/S progression

5. The biventricular hypertrophy pattern usually persists in this age group.

THREE YEARS TIO EIGHT YEARS

1. In right precordial leads dominant S waves are seen.

2. In the left precordial leads, dominant R waves are seen.

3. The adult R/S progression is achieved in this age group

4. In the lt. precordial leads the Q waves are of larger amplitude & it is usually less than 5mm.

EIGHT TO SIXTEEN YEARS

1. The QRS axis falls between 0 10 90 degree with the mean value of 60 degree

2. The adult R/S progression is seen

3. The QRS amplitude are large in the precordial leads

4. The T wave in V1 is usually upright

5. In V1 to V 4 the negative T waves are not unusual

ADULT

1. The QRS axis falls between 0 to 100 degree with the mean value of 50 degree

2. The dominant ventricle is the left ventricle.

3. Dominant R waves are seen in lt. precordial leads and dominant S waves are seen in the rt. precordial leads (the adult R/S progression)

4. There is the anterior orientation of the T wave (V2 to V6 -> upright T waves)

5. PR interval is usually less than 200 milliseconds and the QRS duration is usually less than 100 milliseconds

NORMAL ECG VALUES

HEART RATE

The heart rate in paediatric age group varies with the status of the child at the time of ecg recording, age of the child and physical factors (ex. Fever)

(**davignon et al. Pediatric cardiology)**

Heart rate is mentioned as beats per minute

AGE	**RANGE**	**MEAN**
newborn	90-180	145
6 months	105-185	145
1 year	105-170	132
2 years	90-150	120
4 years	72-135	108
6 years	65-135	100
10 years	65 - 130	100

14 years	60-120	85

Tachycardia is defined as the heart rate when exceeds the normal range for that age. Tachycardia can be caused by

1. Sinus tachycardia

2. Atrial flutter

3.Atrial fibrillation

4. Supraventricular tachycardia

5. Ventricular tachycardia

Bradycardia is defined as when the heart rate is lesser than the lower range of the normal of that age.

1. sinus bradycardia

2. nodal rhythm

3. 2nd degree AV block

4. 3rd degree AV block

RHYTHM

SINUS RHYTHM

At any age the normal rhythm is the sinus rhythm in that SA node is the dominant pacemaker of the entire heart. The P wave axis tells the atria depolarization direction so that it provides the information about the pacemaker cell

The normal P wave axis falls between 0 to 90 degree at any age and it should be only one P wave before each QRS. During the sinus rhythm the P wave should be upright in lead 1 and aVF, inverted in aVR and usually in lead II it is upright

NON SINUS RHYTHM

It may be in the form of absent P waves, abnormal number of P waves and change in the P wave axis.

1. multiple P waves are seen in the following

a. atrial fibrillation

b. atrial flutter

c. atria tachycardia with AV block

d. AV block second or third degree

2. absent P waves is seen in the following

a. SA block

b. AV nodal rhythm.

c. idioventricular rhythm.

3. abnormal P wave axis

a. P wave axis lies in the rt. lower quadrant (>90 degrees)

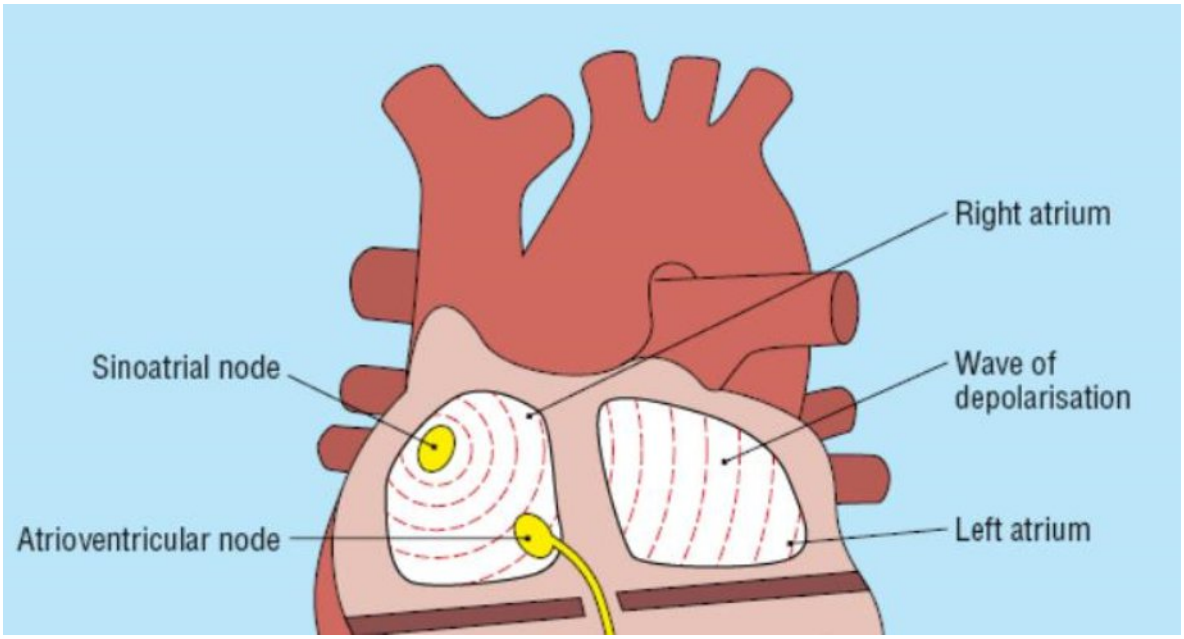
- Incorrectly placed arm leads
- Atrial inversion

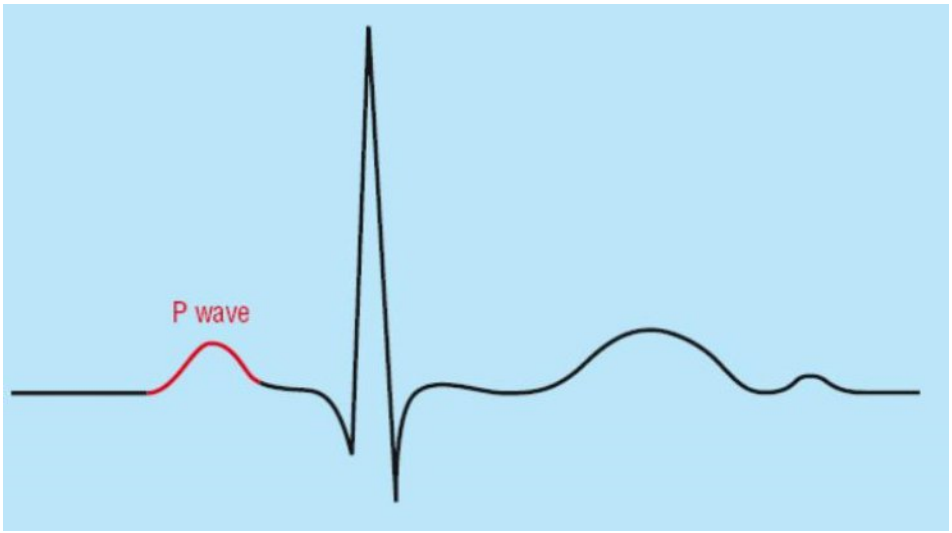
b. orientation of the P wave axis (<0 degree)

- Low atrial ectopic pacemaker
- AV junctional rhythm with retrograde activation of the atrium

4. change in P wave axis is found in the wandering atria pacemaker

P WAVE





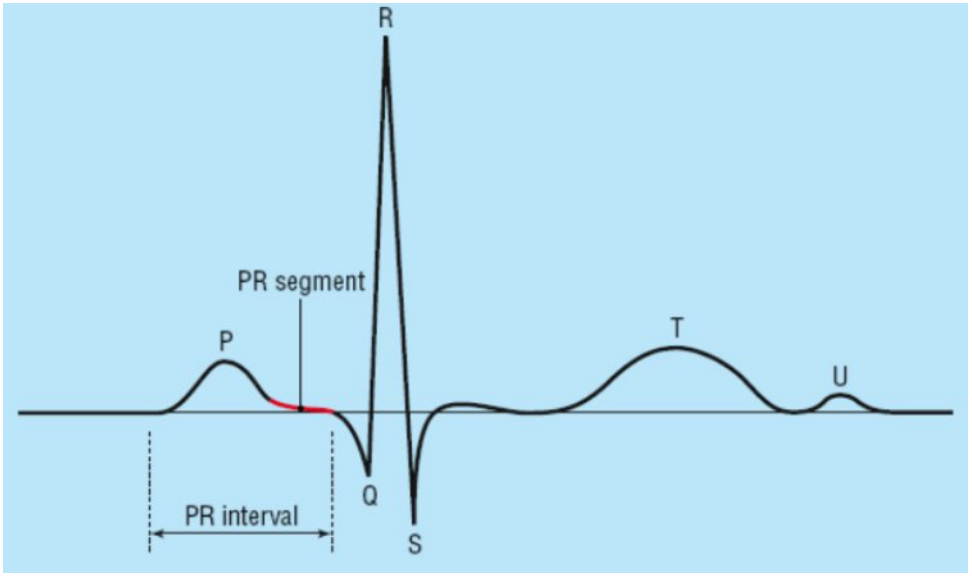
Amplitude

In lead II or any other lead, the mean P wave amplitude is about 1.5mm up to the maximum of 3mm. The P wave amplitude more than 3mm indicates right atrial hypertrophy.

Duration

This represents the atria depolarisation time. Its normal dur. is 0.06 +/- 0.02 second. In infants the max. P wave duration 0.08 second. In left atria hypertrophy there will be the prolonged P wave duration.

PR interval



It tells about the time for the atria depolarisation and delay of the impulse conduction in the AV node. It varies with the heart rate of the age.

PR interval α age / heart rate

Abnormal PR interval(10)

I - short PR interval

1. Lown-ganong-levine syndrome

2. WPW syndrome

3. Pompes disease

4. Forbes disease

5. Duchenne muscular dystrophy

6. pheochromacytoma

7. friedrich ataxia

8. Fabres disease

9. mitral valve prolapsed

10. XYY syndrome

II prolonged PR interval

1. myocarditis

2. congenital heart defects ex. ASD, Ebstein anomaly, endocardial cushion defect

3. digitalis toxicity

4. profound hypoxia

5. hyperkalemia

III variable PR interval

1. Wenckebach phenomenon

2. wandering atrial pacemaker

Age wise lower limits of normal of PR interval.

AGE	**DURATION IN SECONDS**
Less than 12 months	0.075
1-3 years	0.080
3-5 years	0.085
5-12 years	0.090
12-16 years	0.095

adults	0.100

QRS AXIS

The mean vector of ventricular depolarisation represents the QRS axis. This is the most useful in determining ventricular hypertrophy. Usually the normal infant has right axis deviation. In newborn period the mean QRS axis is 125 degree, but the value upto 180 degree is considered as normal. By the 1 month of age mean QRS axis reaches 90 degree and reaches the adult value of 50 degree at three years of age(10).

AGE	**RANGE**	**MEAN**
new born	+30 to +180	+110
1-3 months	+10 to +125	+70
3 months to 3 yrs	+5 to +110	+60
> 3 years	20 to 120	+60
adult	-30 to 105	50

ABNORMAL QRS AXIS

1.Rt. axis deviation: (QRS axis> upper limit of the normal for that age)

a. rt. bundle branch block

b. rt. ventricular hypertrophy

2. lt. axis deviation: (QRS axis< upper limit of the normal for that age)

a. left bundle branch block

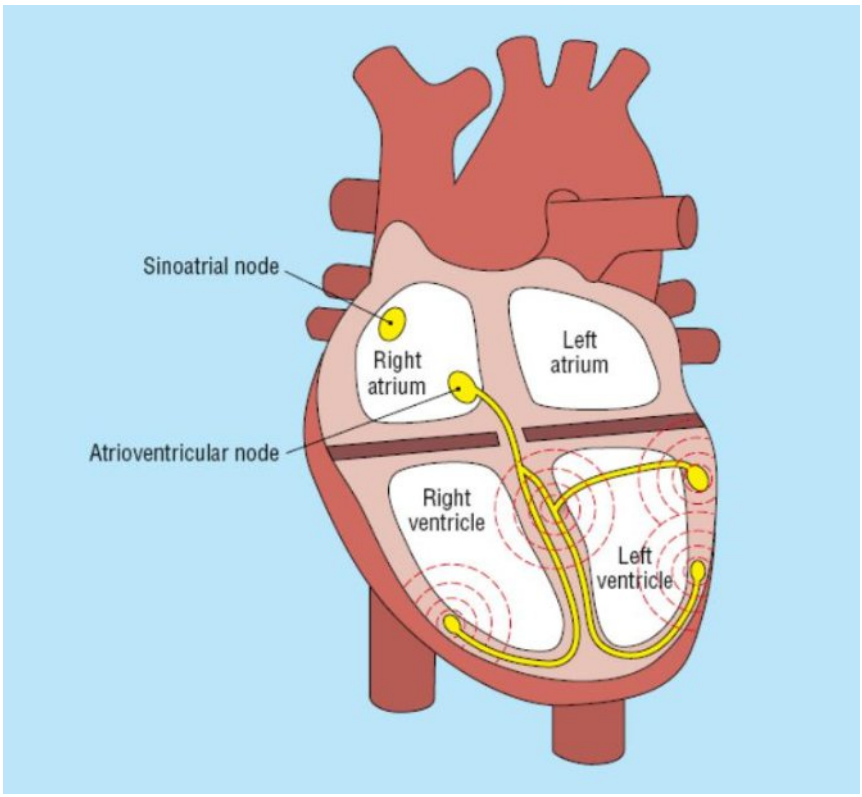
b. left ventricular hypertrophy

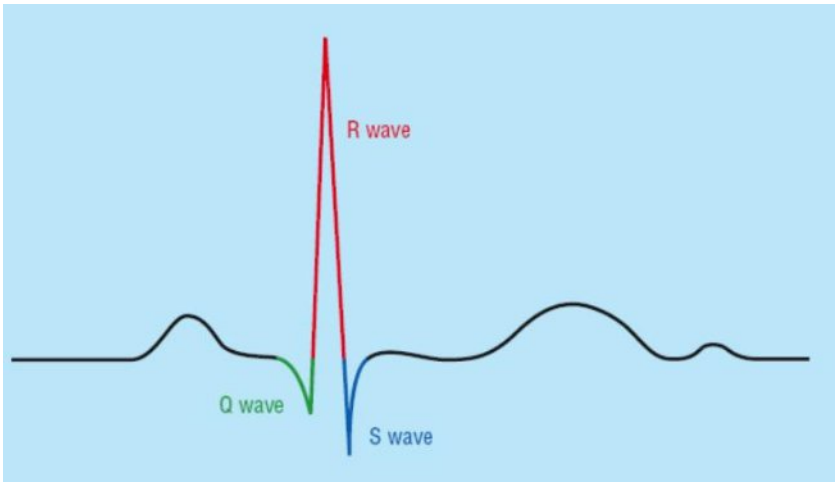
3. Superiorly oriented QRS axis(in lead aVF, S wave > R wave.)

a. lt. anterior hemiblock especially in endocardial cushion defect and tricuspid atresia.

b. rt. bundle branch block (terminal QRS axis)

QRS DURATION





It is the time required for the depolarisation of the ventricles.

AGE	**QRS DURATION(SEC)**

Preterm	0.04
Term	0.05
1-3 yrs	0.06
>3 yrs	0.07
adults	0.08

ABNORMAL QRS DURATION

This implies that abnormal propagation of the impulse through the ventricles or abnormally delayed combinedly called as ventricular conduction disturbances. It is seen in the following

1. bundle branch blocks

2. intra ventricular blocks

3. pre excitation

4. ventricular arrhythmias

5. implanted ventricular pacemakers

6. ventricular hypertrophy

QRS AMPLITUDE

It is most important for the diagnosis of the ventricular hypertrophy.

Abnormal QRS amplitude

A. high voltage QRS complex

1.ventricular hypertrophy

2. ventricular conduction disturbances

B. low voltage QRS complexes

1. pericardial effusion

2. hyperthyroidism

3. constrictive pericarditis

4. myocarditis

5. healthy neonate

Q WAVE

It represents the ventricular septum depolarisation. The initial part of the QRS wave is directed rightward & superiorly so Q waves are seen in the lt. leads (

lead1, V5, V 6) and in the inferior leads(lead II III and aVF). Normally in the V1 lead the Q waves are absent except for the rare instances.

In lead aVF & V6 the maximum Q wave amplitude is lesser than 5mm regardless of the age.

The avg duration of the Q wave is 0.02 sec & it usually not exceeds 0.037.

Abnormal Q waves

A. No Q waves in V6

1. L-TGA
2. mirror image dextrocardia
3. left bundle branch block
4. single ventricle

B. Q waves in V1

1. severe right ventricle hypertrophy
2. L-TGA
3. single ventricle

C. Deep Q waves

1. biventricular hypertrophy
2. LVH of volume overload type
3. abnormal diastolic compliance
4. hypertrophy of ventricular septum

D. Deep and wide Q waves

1. myocardial fibrosis
2. hypertrophy cardiomyopathy

R/S PROGRESSION

After birth, R wave's amplitude in V 5 gradually increases at the same time there is a progressive decrease of S wave amplitude in V6. In infants there is the complete reversal of R/S progression with dominant S in V5 V6 and dominant R in V1 V2. In between 1 month to 3 years of life there is a partial reversal and after 3 yrs there is the complete adult R/S progression. Deviation noted in the following

1. Ventricular conduction disturbances

2. Ventricular hypertrophy

3. Single ventricle

R/S RATIO

It is the ratio of R wave voltage to S wave voltage in certain age. It tells about the electromotive forces of the right and left ventricle. R/S ratio in V6 denotes the ratio of LV force to the RV force. The same in V1 denotes the ratio of RV force to LV force. In the newborn period due to predominance of the right ventricle the R/S ratio is greater in right precordial leads and smaller in the left precordial leads. In adults due to predominance of the left ventricle the R/S ratio is greater in the left precordial leads and smaller in the right precordial leads

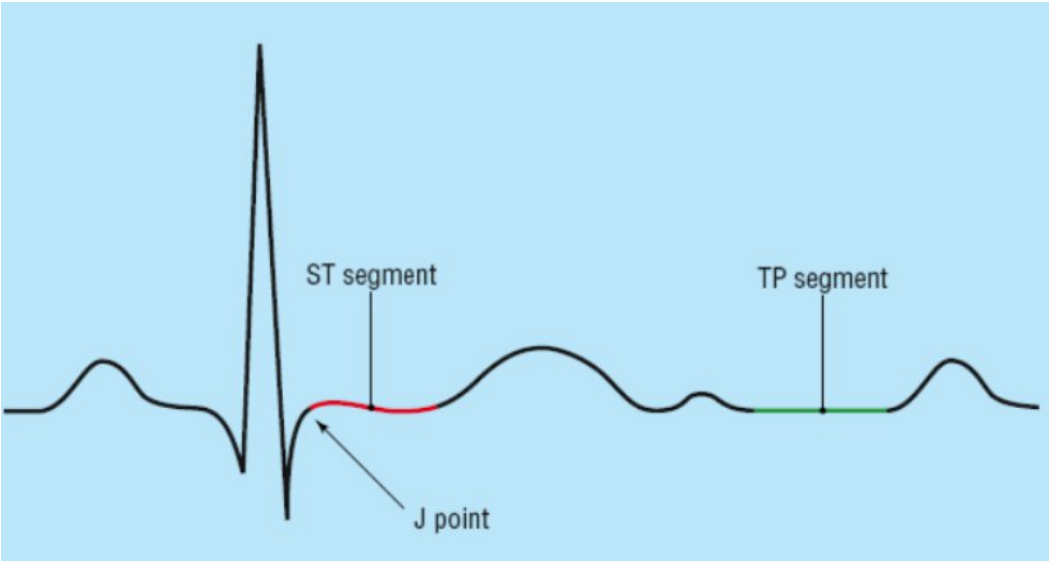
>ULN in right precordial leads - RVH

<LLN in right precordial leads - LVH

>ULN in left precordial leads - LVH

< LLN in left precordial leads - RVH

ST SEGMENT:



It occurs after the ventricular depolarization and before the ventricular repolarization. It is normally horizontal and isoelectric.in the left precordial leads ,shift upto 2mm is considered as normal.

Abnormal ST segment(Elevated or depressed)

1.pericarditis

2.myocarditis

3.myocardial ischemia

4.hyperkalemia

5.hypokalemia

6.severe ventricular hypertrophy

6.ventricular aneurysm

T wave:

It represents the ventricular repolarization process.it is best measured in the left precordial leads.

Normally,

In V6,

<1 year: 5 mm

>1 year: 7 mm

Tall peaked T waves

A.Hyperkalemia

B.LVH

C.cerebral hemorrhage

Flat T waves

a.Healthy neonates

b. hypothyroidism

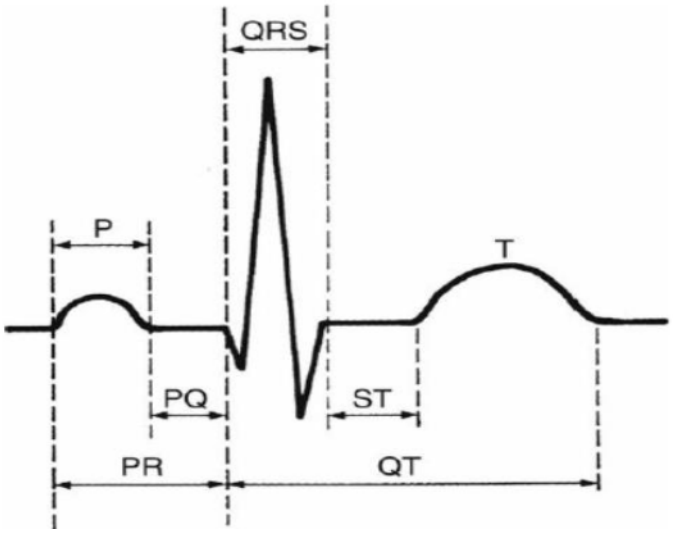
c.hypokalemia

d.pericarditus

e.myocarditis

f.Digitalis effect

QT INTERVAL:



It is the time required for both ventricular depolarization and repolarization.measurement of QT interval is very important because long Qt inv is associated with the ventricular arrhythmias.

The qt interval varies with the heart rate.so the QT interval is interpreted in relation with the heart rate .

Bazett formula(52) :

$$QT_c = \frac{\text{QT interval}}{\sqrt{\text{RR interval}}}$$

Bazett's formula is the most commonly used due to its simplicity. It over-corrects at heart rates > 100 bpm and under-corrects at heart rates < 60 bpm, but provides an adequate correction for heart rates ranging from 60 – 100 bpm

Fridericia formula(53):

$$QTcF = \frac{QT}{\sqrt[3]{RR}}$$

At heart rates outside of the 60 – 100 bpm range, the Fredericia or Framingham corrections are more accurate and should be used instead(8)

MATERIALS AND METHODS

The material consisted of 76 term newborn infants of which are males and are females. The newborn infants were examined clinically, and echocardiography was done before doing the electrocardiography in the Kilpauk medical college and hospital, Chennai. The data of each child is collected in the specific proforma that includes the newborn name, age(hrs of life),sex, parity of the mother

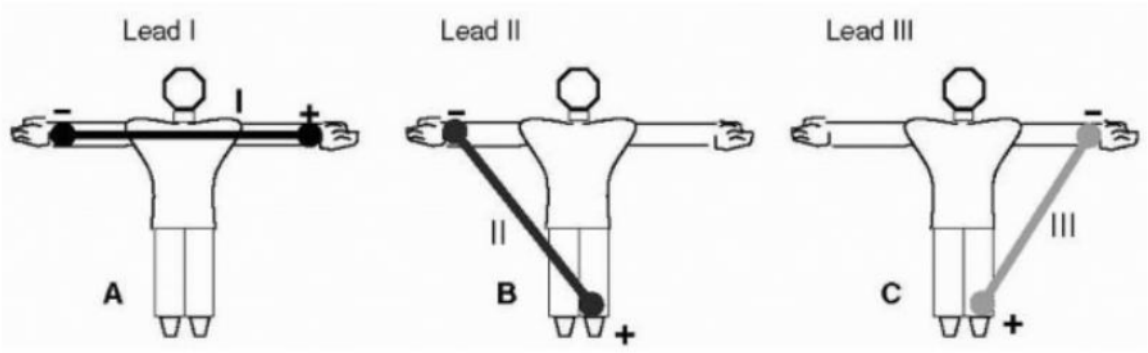
The detailed echocardiography was done by the cardiologist to rule out the congenital heart disease. After ruling out the congenital heart disease by the echo ,the baby is taken to the ecg room for taking the electrocardiogram.

A 12 lead Electrocardiogram was recorded using the portable heat writing electrocardiograph with the frequency range of 0-150 Hz and the sampling

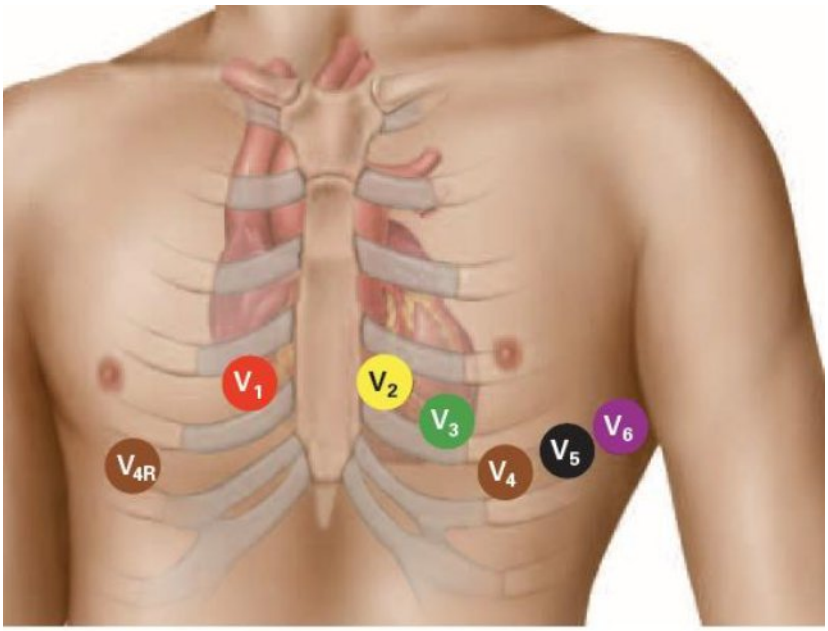
frequency of 1000 Hz.Special newborn disposable electrodes are used and the electrodes are positioned as recommended by the American heart association

POSITIVE AND NEGATIVE TERMINALS OF LIMB LEADS:

Lead I	Lead II	Lead III
RA negative	RA negative	LA negative
LA positive	LL positive	LL positive
RL ground	LA ground	RA ground

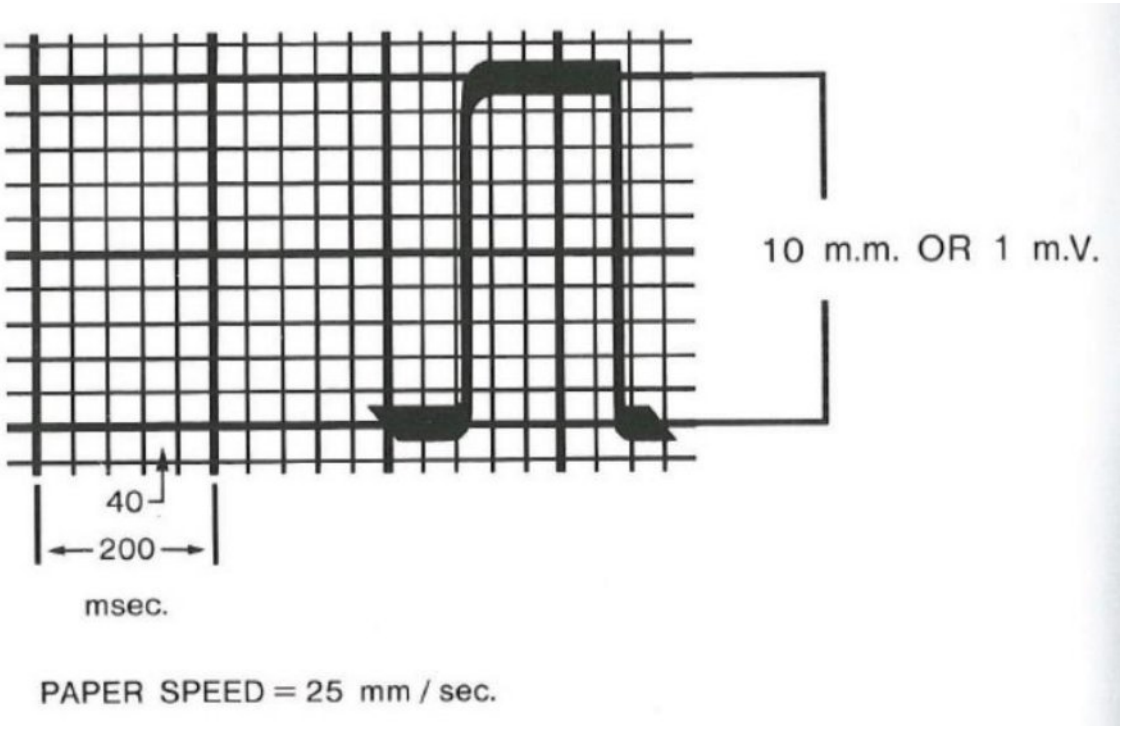


POSITION OF THE PRECODIAL LEADS:



Lead	Electrode Placement
V_1	Fourth intercostal space at right sternal border
V_2	Fourth intercostal space at left sternal border
V_3	Midpoint of a straight line connecting V_2 and V_4
V_4	Fifth intercostal space on midclavicular line
V_5	Fifth intercostal space anterior axillary line
V_6	Fifth intercostal space midaxillary line

Conventional 12 lead ecg was recorded with the control switches set at calibration of 10mm/mv and at the paper speed of 25mm /sec.



The following measurements are taken including the Heart rate,P duration,PR interval, QRS duration, QT interval, QTc by Bazett, ,QTc by Fridericia, P axis ,QRS axis, T axis, R V1,SV6,RV6,SV1,QIII,QV6.

OBSERVATION AND RESULTS

GENDER DISTRIBUTION OF THE STUDY POPULATION

This study was conducted in 76 newborn infants within the 72 hours of life. Out of that 40(52.63%) were males and 36(47.36%) were females.

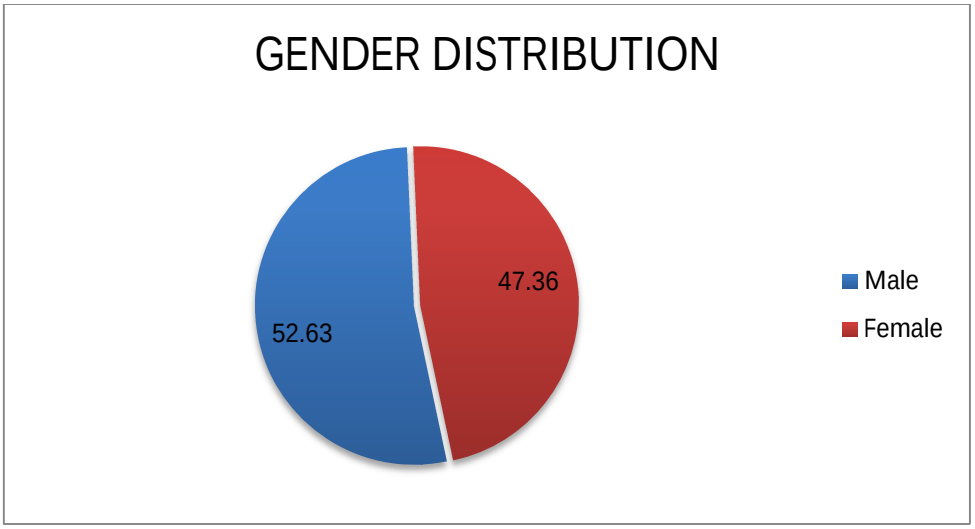


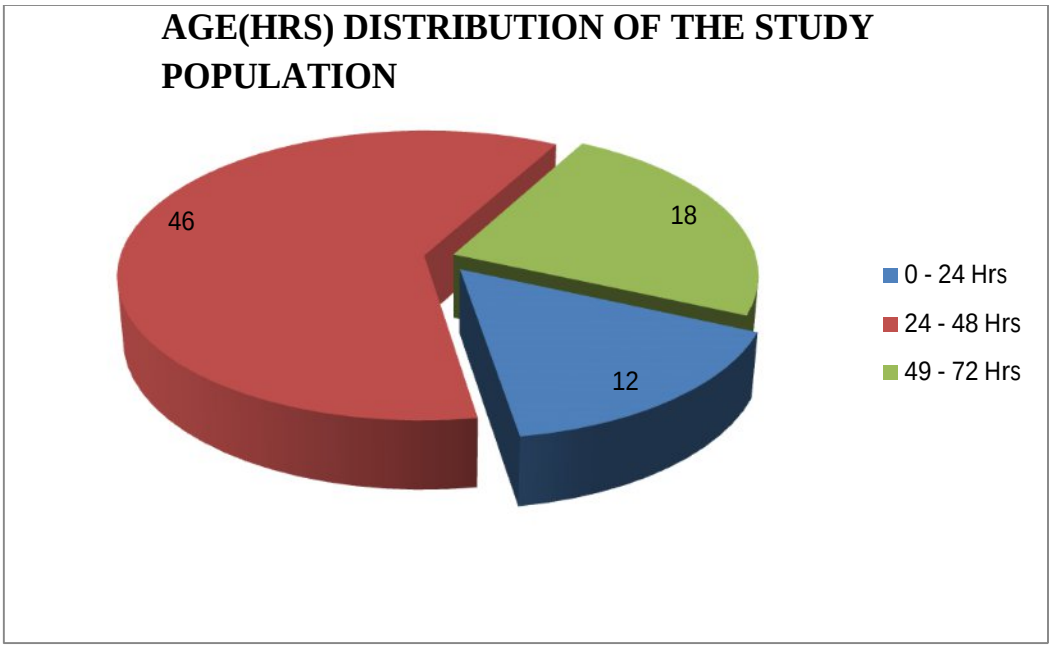
TABLE 1.GENDER DISTRIBUTION OF THE STUDY POPULATION

SEX	MALE	FEMALE
SUBJECTS	52.63%	47.36%

AGE(HRS) DISTRIBUTION OF THE STUDY POPULATION

TABLE 2:

AGE(HRS)	NO.OF SUBJECTS	PERCENTAGE
0-24	12	15.78%
25-48	46	60.52%
49-72	18	23.68%



BIRTH WEIGHT DISTRIBUTION OF THE STUDY POPULATION:

TABLE :3

BIRTH WT.	NO.OF SUBJECTS	PERCENTAGE
2-2.5 KG	9	11.84%
2.51-3 KG	28	36.84%
3.1-3.5 KG	32	42.10%
>3.5 KG	7	9.21%

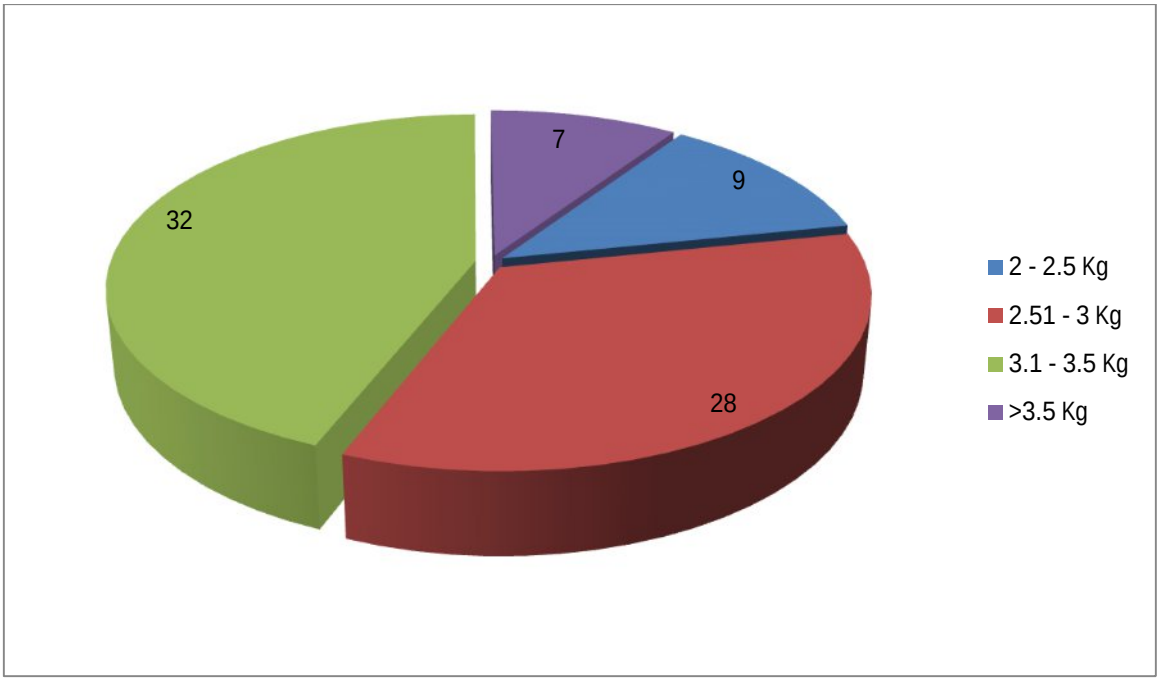


TABLE 4: HEART RATE BY AGE

	Heart rate				95% Confidence Interval for Mean	
	N	Mean	Std. Deviation	Std. Error	Lower Bound	Upper Bound
0-24 hrs	12	126.67	15.376	4.439	116.90	136.44
25-48 hrs	46	127.72	15.314	2.258	123.17	132.27
49-72 hrs	18	120.11	15.289	3.604	112.51	127.71
Total	76	125.75	15.444	1.772	122.22	129.28

	Heart rate	
	Minimum	Maximum
0-24 hrs	89	142
25-48 hrs	92	153
49-72 hrs	92	149
Total	89	153

ANOVA

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	760.479	2	380.240	1.621	.205
Within Groups	17127.771	73	234.627		
Total	17888.250	75			

The mean heart rate observed was 125.75/min with the standard deviation of 15.44. The heart rate difference between the groups was not statistically significant ($p>0.005$)

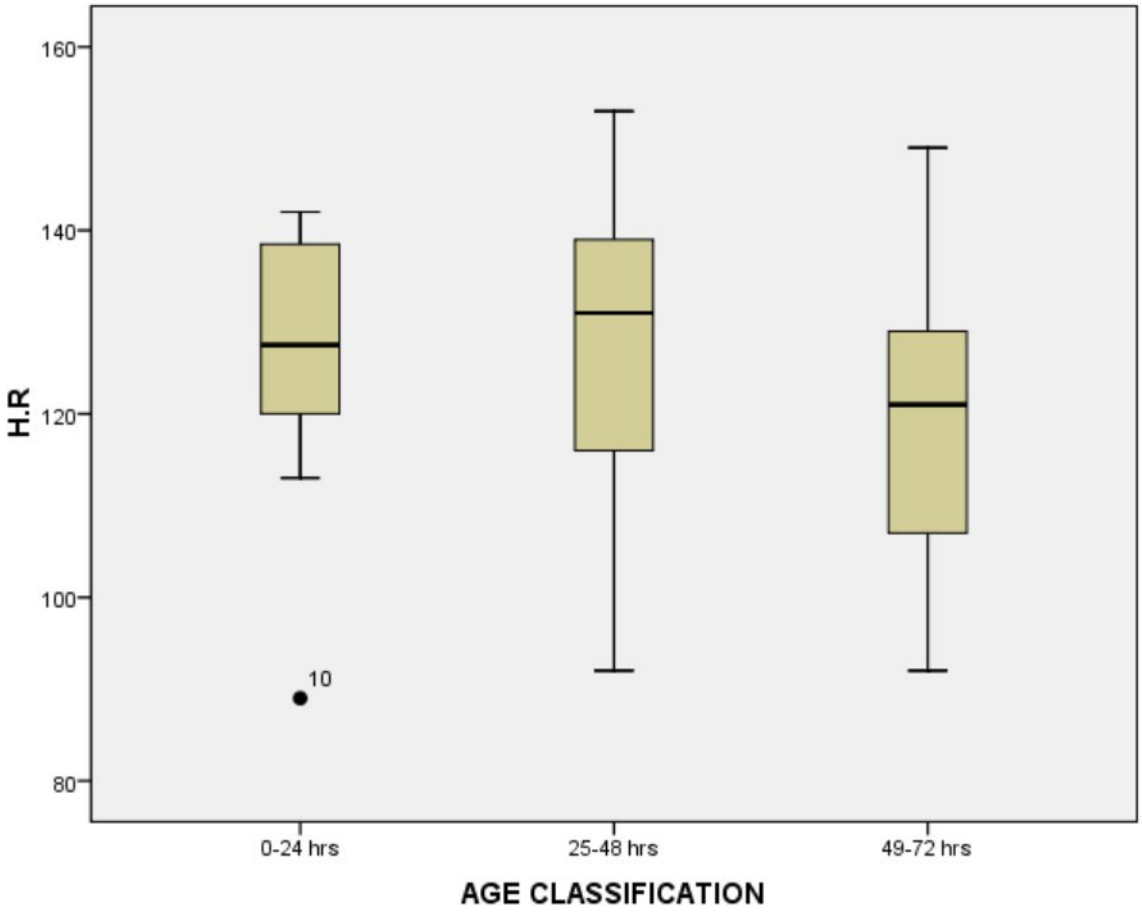


TABLE 5:HEART RATE BY BIRTH WEIGHT

Descriptives

	H.R				95% Confidence Interval for Mean	
	N	Mean	Std. Deviation	Std. Error	Lower Bound	Upper Bound
2 - 2.5 kg	9	133.89	12.850	4.283	124.01	143.77
2.51 - 3 kg	28	121.75	15.650	2.958	115.68	127.82

3.1 - 3.5 kg	32	125.75	15.707	2.777	120.09	131.41
>3.5 kg	7	131.29	13.213	4.994	119.07	143.51
Total	76	125.75	15.444	1.772	122.22	129.28

The mean heart rate observed in the 2-2.5 kg age group was higher 133.89 when compared to the total mean of 125.75.

Descriptives

	H.R	
	Minimum	Maximum
2 - 2.5 kg	111	149
2.51 - 3 kg	92	153
3.1 - 3.5 kg	89	149
>3.5 kg	115	148
Total	89	153

ANOVA

H.R

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	1258.683	3	419.561	1.817	.152
Within Groups	16629.567	72	230.966		

ANOVA

H.R

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	1258.683	3	419.561	1.817	.152
Within Groups	16629.567	72	230.966		
Total	17888.250	75			

The difference in the mean heart rate between the birth wt. groups was not statistically significant.

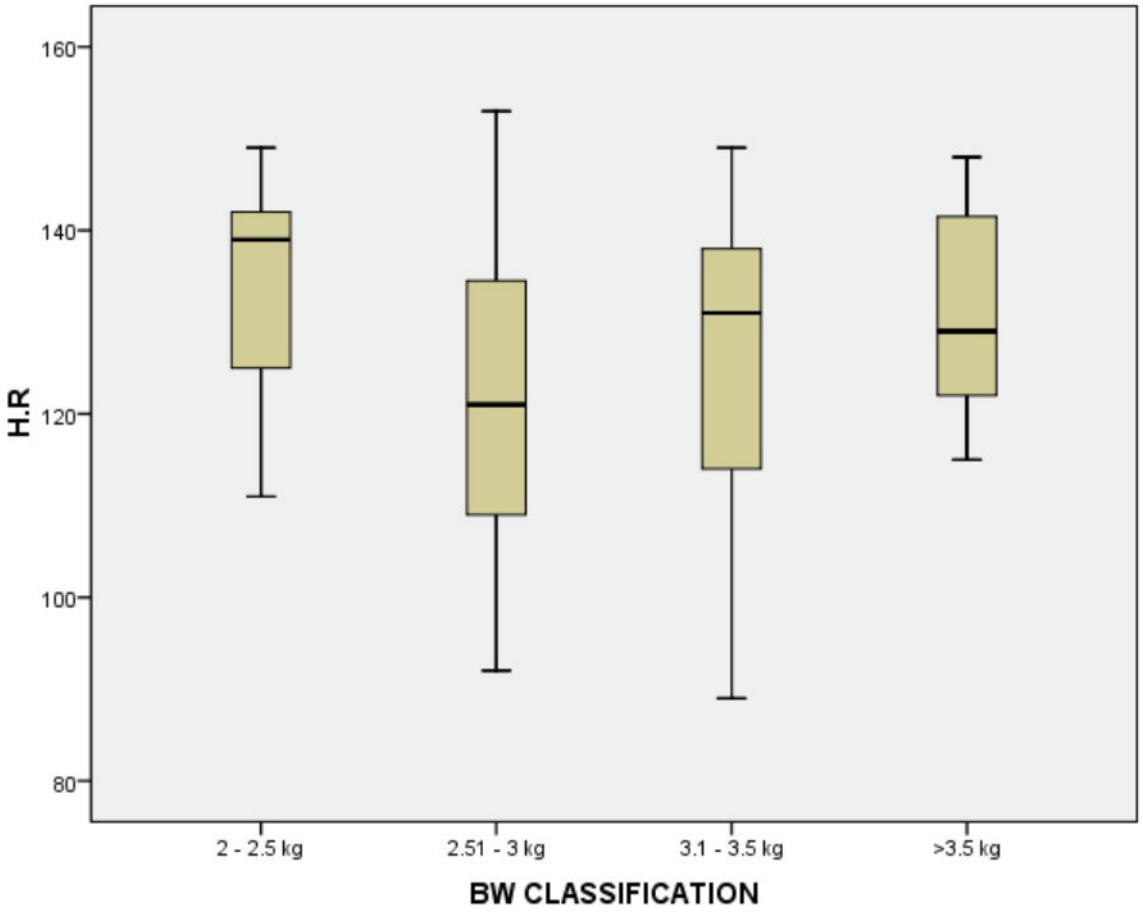


TABLE 6: HEART RATE BY GENDER

Group Statistics

	SEX	N	Mean	Std. Deviation	Std. Error Mean
H.R	MALE	40	125.93	14.364	2.271
	FEMALE	36	125.56	16.766	2.794

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means	
		F	Sig.	t	df
H.R	Equal variances assumed	.759	.386	.103	74
	Equal variances not assumed			.103	69.354

Independent Samples Test

		t-test for Equality of Means		
		Sig. (2-tailed)	Mean Difference	Std. Error Difference
H.R	Equal variances assumed	.918	.369	3.572
	Equal variances not assumed	.919	.369	3.601

Independent Samples Test

		t-test for Equality of Means	
		95% Confidence Interval of the Difference	
		Lower	Upper
H.R	Equal variances assumed	-6.747	7.486
	Equal variances not assumed	-6.814	7.552

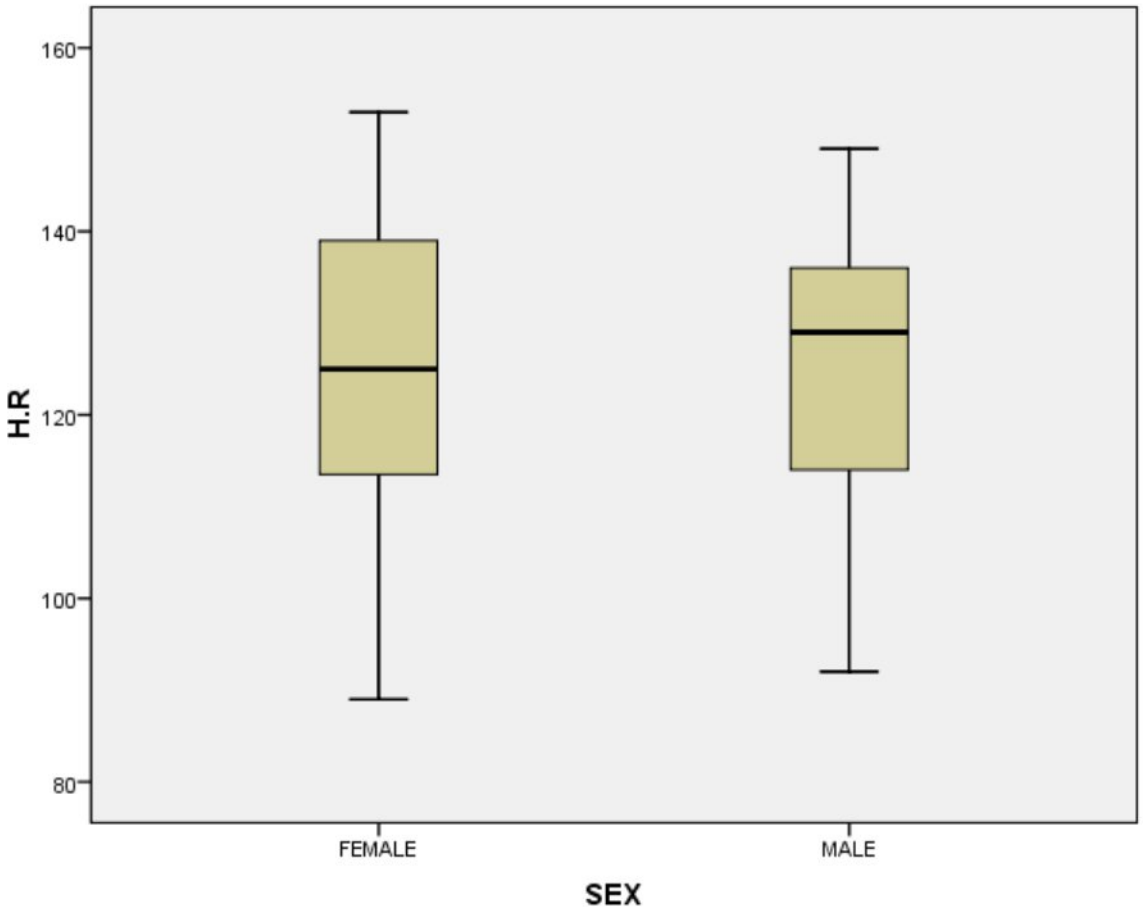


TABLE 7: P DURATION, PR INTERVAL, QRS DURATION (MS) BY AGE

Descriptives

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean

						Lower Bound
P DUR(MS)	0-24 hrs	12	48.83	11.808	3.409	41.33
	25-48 hrs	46	49.74	10.485	1.546	46.63
	49-72 hrs	18	47.17	9.096	2.144	42.64
	Total	76	48.99	10.311	1.183	46.63
PR INV(MS)	0-24 hrs	12	106.17	14.154	4.086	97.17
	25-48 hrs	46	103.26	13.017	1.919	99.40
	49-72 hrs	18	98.83	11.823	2.787	92.95
	Total	76	102.67	12.978	1.489	99.71
QRS DUR(MS)	0-24 hrs	12	59.42	11.759	3.394	51.95
	25-48 hrs	46	62.02	8.901	1.312	59.38
	49-72 hrs	18	61.44	5.628	1.327	58.65
	Total	76	61.47	8.709	.999	59.48

The mean P wave duration observed was 48.99 ms , s.d of 10.31,with 95% CI for mean lower bound 46.63 and mean upper bound 51.34 ms.

The mean PR interval observed was 102.67 ms ,s.d of 12.97,with 95% CI for mean lower bound 99.71 and the mean upper bound 105.64 ms

The mean QRS duration observed was 61.47 ms,s.d of 8.7 with 95% CI for mean lower bound 59.48 and the mean upper bound 63.46 ms.

Descriptives

		95% Confidence Interval for Mean		
		Upper Bound	Minimum	Maximum
P DUR(MS)	0-24 hrs	56.34	35	66
	25-48 hrs	52.85	31	76
	49-72 hrs	51.69	28	65
	Total	51.34	28	76
PR INV(MS)	0-24 hrs	115.16	93	141
	25-48 hrs	107.13	62	136
	49-72 hrs	104.71	81	116
	Total	105.64	62	141
QRS DUR(MS)	0-24 hrs	66.89	42	74
	25-48 hrs	64.66	42	79
	49-72 hrs	64.24	49	72
	Total	63.46	42	79

ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
P DUR(MS)	Between Groups	85.951	2	42.975	.398	.673
	Within Groups	7887.036	73	108.042		
	Total	7972.987	75			
PR INV(MS)	Between Groups	427.740	2	213.870	1.279	.284
	Within Groups	12205.036	73	167.192		
	Total	12632.776	75			
QRS DUR(MS)	Between Groups	64.608	2	32.304	.419	.659
	Within Groups	5624.339	73	77.046		
	Total	5688.947	75			

The P wave duration, PR interval and the QRS duration variation between the age groups was not statistically significant.

MEAN P DURATION, PR INTERVAL, QRS DURATION (MS) BY AGE (HRS)

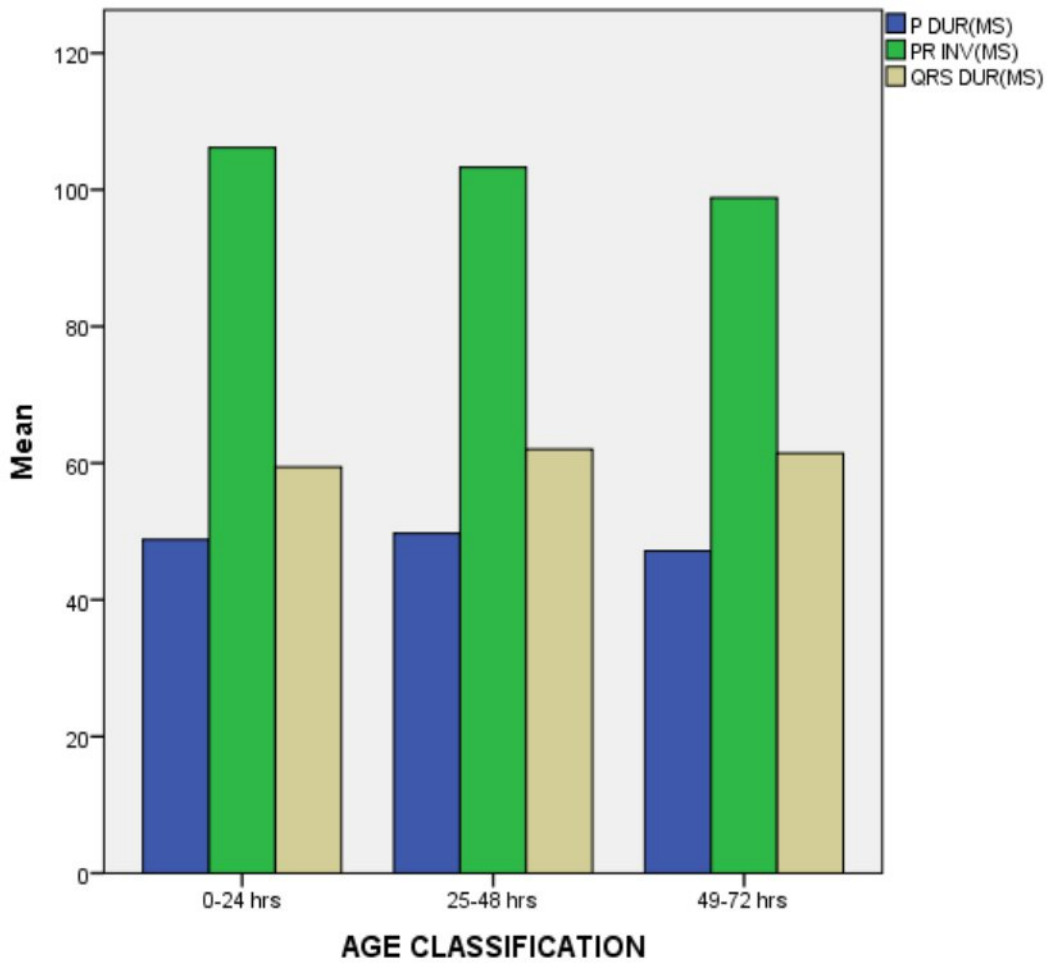


TABLE 8: P DURATION, PR INTERVAL, QRS DURATION (MS) BY BIRTH WEIGHT

Descriptives

		N	Mean	Std. Deviation	Std. Error
P DUR(MS)	2 - 2.5 kg	9	50.67	8.139	2.713
	2.51 - 3 kg	28	47.75	11.276	2.131
	3.1 - 3.5 kg	32	48.97	10.769	1.904
	>3.5 kg	7	51.86	6.939	2.623
	Total	76	48.99	10.311	1.183
PR INV(MS)	2 - 2.5 kg	9	106.33	22.677	7.559
	2.51 - 3 kg	28	100.57	11.827	2.235
	3.1 - 3.5 kg	32	104.16	11.025	1.949
	>3.5 kg	7	99.57	9.931	3.753
	Total	76	102.67	12.978	1.489
QRS DUR(MS)	2 - 2.5 kg	9	64.11	9.688	3.229
	2.51 - 3 kg	28	60.96	9.264	1.751
	3.1 - 3.5 kg	32	60.50	8.211	1.452

	>3.5 kg	7	64.57	7.786	2.943
	Total	76	61.47	8.709	.999

Descriptives

		95% Confidence Interval for Mean			
		Lower Bound	Upper Bound	Minimum	Maximum
P DUR(MS)	2 - 2.5 kg	44.41	56.92	36	66
	2.51 - 3 kg	43.38	52.12	28	65
	3.1 - 3.5 kg	45.09	52.85	31	76
	>3.5 kg	45.44	58.27	38	60
	Total	46.63	51.34	28	76
PR INV(MS)	2 - 2.5 kg	88.90	123.76	62	141
	2.51 - 3 kg	95.99	105.16	82	127
	3.1 - 3.5 kg	100.18	108.13	87	136
	>3.5 kg	90.39	108.76	81	108
	Total	99.71	105.64	62	141
QRS DUR(MS)	2 - 2.5 kg	56.66	71.56	53	78
	2.51 - 3 kg	57.37	64.56	42	76
	3.1 - 3.5 kg	57.54	63.46	42	74
	>3.5 kg	57.37	71.77	56	79

Descriptives

		95% Confidence Interval for Mean			
		Lower Bound	Upper Bound	Minimum	Maximum
P DUR(MS)	2 - 2.5 kg	44.41	56.92	36	66
	2.51 - 3 kg	43.38	52.12	28	65
	3.1 - 3.5 kg	45.09	52.85	31	76
	>3.5 kg	45.44	58.27	38	60
	Total	46.63	51.34	28	76
PR INV(MS)	2 - 2.5 kg	88.90	123.76	62	141
	2.51 - 3 kg	95.99	105.16	82	127
	3.1 - 3.5 kg	100.18	108.13	87	136
	>3.5 kg	90.39	108.76	81	108
	Total	99.71	105.64	62	141
QRS DUR(MS)	2 - 2.5 kg	56.66	71.56	53	78
	2.51 - 3 kg	57.37	64.56	42	76
	3.1 - 3.5 kg	57.54	63.46	42	74
	>3.5 kg	57.37	71.77	56	79
	Total	59.48	63.46	42	79

The PR interval is slightly higher in 2-2.5 kg birth wt. group when compared to the other age group but it is not statistically significant .

ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
P DUR(MS)	Between Groups	125.911	3	41.970	.385	.764
	Within Groups	7847.076	72	108.987		
	Total	7972.987	75			
PR INV(MS)	Between Groups	381.986	3	127.329	.748	.527
	Within Groups	12250.790	72	170.150		
	Total	12632.776	75			
QRS DUR(MS)	Between Groups	167.380	3	55.793	.728	.539
	Within Groups	5521.567	72	76.688		
	Total	5688.947	75			

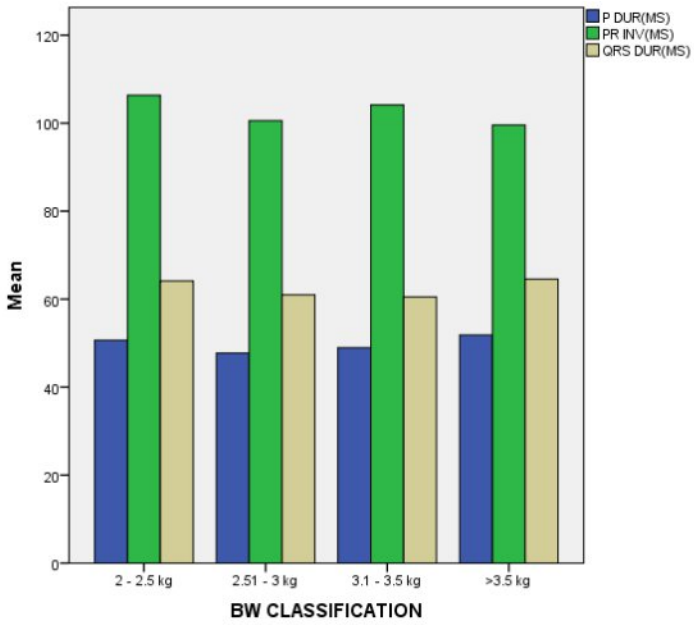


TABLE 9: P DURATION, PR INTERVAL, QRS DURATION (MS) BY GENDER

Group Statistics

	SEX	N	Mean	Std. Deviation	Std. Error Mean
P DUR(MS)	MALE	40	50.15	10.693	1.691
	FEMALE	36	47.69	9.856	1.643
PR INV(MS)	MALE	40	105.40	12.639	1.998
	FEMALE	36	99.64	12.844	2.141
QRS DUR(MS)	MALE	40	61.68	8.980	1.420
	FEMALE	36	61.25	8.520	1.420

Independent Samples Test

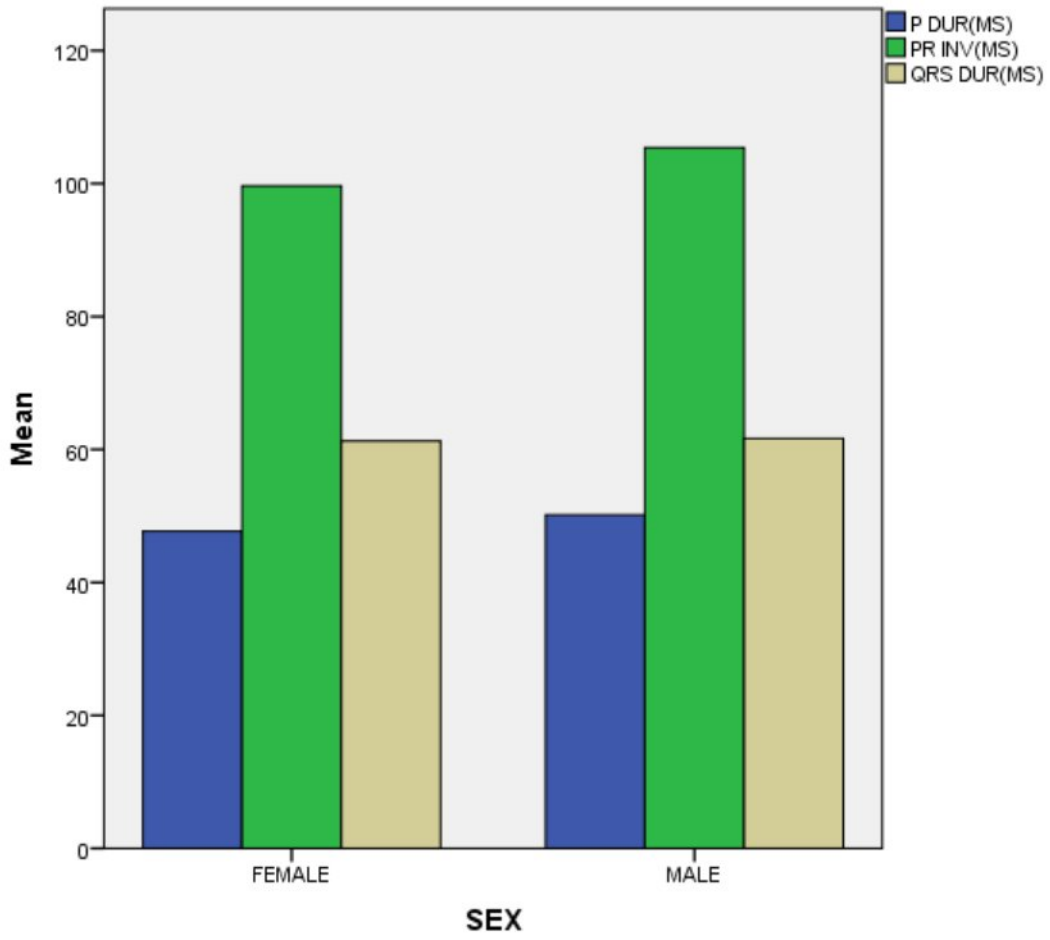
		Levene's Test for Equality of Variances		t-test for Equality of Means	
		F	Sig.	t	df
P DUR(MS)	Equal variances assumed	.376	.541	1.037	74
	Equal variances not assumed			1.042	73.953
PR INV(MS)	Equal variances assumed	.402	.528	1.969	74
	Equal variances not assumed			1.967	72.898
QRS DUR(MS)	Equal variances assumed	.541	.464	.211	74
	Equal variances not assumed			.212	73.783

Independent Samples Test

		t-test for Equality of Means		
		Sig. (2-tailed)	Mean Difference	Std. Error Difference
P DUR(MS)	Equal variances assumed	.303	2.456	2.367
	Equal variances not assumed	.301	2.456	2.357
PR INV(MS)	Equal variances assumed	.053	5.761	2.926
	Equal variances not assumed	.053	5.761	2.929
QRS DUR(MS)	Equal variances assumed	.833	.425	2.014
	Equal variances not assumed	.833	.425	2.008

Independent Samples Test

		t-test for Equality of Means	
		95% Confidence Interval of the Difference	
		Lower	Upper
P DUR(MS)	Equal variances assumed	-2.262	7.173
	Equal variances not assumed	-2.241	7.152
PR INV(MS)	Equal variances assumed	-.069	11.591
	Equal variances not assumed	-.076	11.598
QRS DUR(MS)	Equal variances assumed	-3.587	4.437
	Equal variances not assumed	-3.576	4.426



The male newborn group has slightly higher mean P wave duration when compared to the female newborn group (50.15 vs 47.69)

The male newborn group has slightly higher mean PR interval duration when compared to the female newborn group (105.4 vs 99.64)

The was no significant difference in the mean QRS duration in the male and the female newborn groups.

But the differences in the gender variation for P wave duration ,PR interval, QRCS duration was not statistically significant.

TABLE 10. QT INTERVAL, QTc -BAZETT,QTc FRIDERICIA BY AGE

Descriptives

		N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean
						Lower Bound
QT INV(MS)	0-24 hrs	12	281.33	21.706	6.266	267.54
	25-48 hrs	46	280.59	26.785	3.949	272.63
	49-72 hrs	18	278.50	23.583	5.559	266.77
	Total	76	280.21	25.032	2.871	274.49
QTC BAZETT	0-24 hrs	12	409.58	46.302	13.366	380.16
	25-48 hrs	46	408.33	41.284	6.087	396.07
	49-72 hrs	18	395.50	41.825	9.858	374.70
	Total	76	405.49	42.013	4.819	395.89
QTC FRID	0-24 hrs	12	360.67	35.935	10.374	337.83
	25-48 hrs	46	358.76	34.155	5.036	348.62
	49-72 hrs	18	350.67	33.731	7.950	333.89
	Total	76	357.14	34.072	3.908	349.36

Descriptives

		95% Confidence Interval for Mean		
		Upper Bound	Minimum	Maximum
QT INV(MS)	0-24 hrs	295.12	244	316
	25-48 hrs	288.54	232	331
	49-72 hrs	290.23	251	336
	Total	285.93	232	336
QTC BAZETT	0-24 hrs	439.00	297	471
	25-48 hrs	420.59	324	494
	49-72 hrs	416.30	328	472
	Total	415.09	297	494
QTC FRID	0-24 hrs	383.50	278	408
	25-48 hrs	368.90	302	425
	49-72 hrs	367.44	300	407
	Total	364.93	278	425

The mean QTc interval by both Bazett and fridericia was high in 0-24 hrs age group . The mean QTc interval by bazett is considerably higher than the calculated by the fridericia.

		Sum of Squares	df	Mean Square	F	Sig.
QT INV(MS)	Between Groups	74.313	2	37.156	.058	.944
	Within Groups	46922.319	73	642.771		
	Total	46996.632	75			
QTC BAZETT	Between Groups	2367.461	2	1183.731	.665	.518
	Within Groups	130017.525	73	1781.062		
	Total	132384.987	75			
QTC FRID	Between Groups	1024.372	2	512.186	.435	.649
	Within Groups	86041.036	73	1178.644		
	Total	87065.408	75			

The difference within the groups of QTc by both bazett&fridericia was not statistically significant

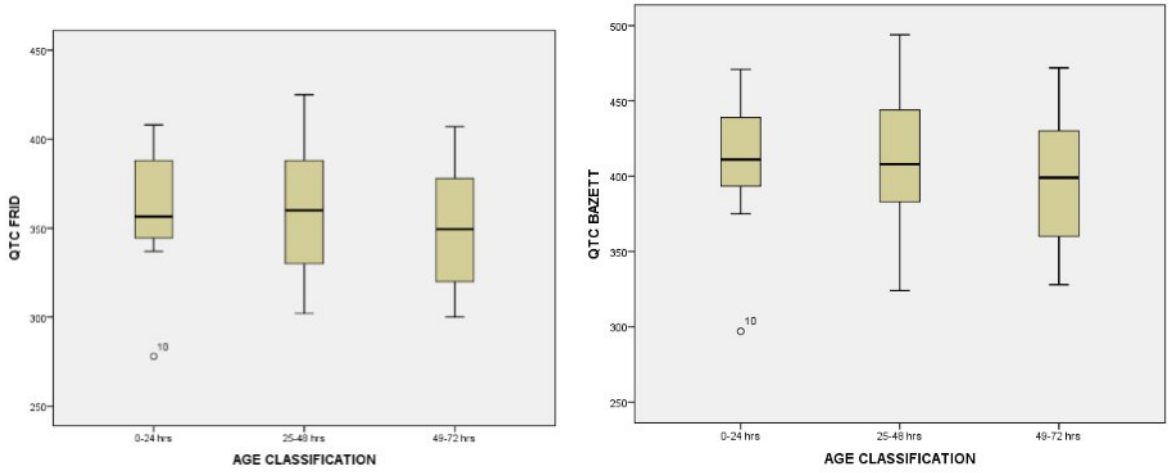


TABLE 11. COMPARISON OF QTc INTERVAL BAZETT Vs FRIDERICIA BY AGE

Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	QTC BAZETT	405.49	76	42.013	4.819
	QTC FRID	357.14	76	34.072	3.908

Paired Samples Correlations

		N	Correlation	Sig.
Pair 1	QTC BAZETT & QTC FRID	76	.970	.000

Paired Samples Test

		Paired Differences			
					95% Confidence Interval of the Difference
		Mean	Std. Deviation	Std. Error Mean	Lower
Pair 1	QTC BAZETT - QTC FRID	48.342	12.262	1.407	45.540

The mean QTc interval by the bazett formula was 405.49 ms with sd of 42.013 and The mean QTc interval by the fridericia formula was 357.14 ms with sd of 34.07 ms. The difference between the two formula was **statistically significant p value (0.000)**

Paired Samples Test

	Paired Differences	t	df	Sig. (2-tailed)

		95% Confidence Interval of the Difference			
		Upper			
Pair 1	QTC BAZETT - QTC FRID	51.144	34.369	75	.000

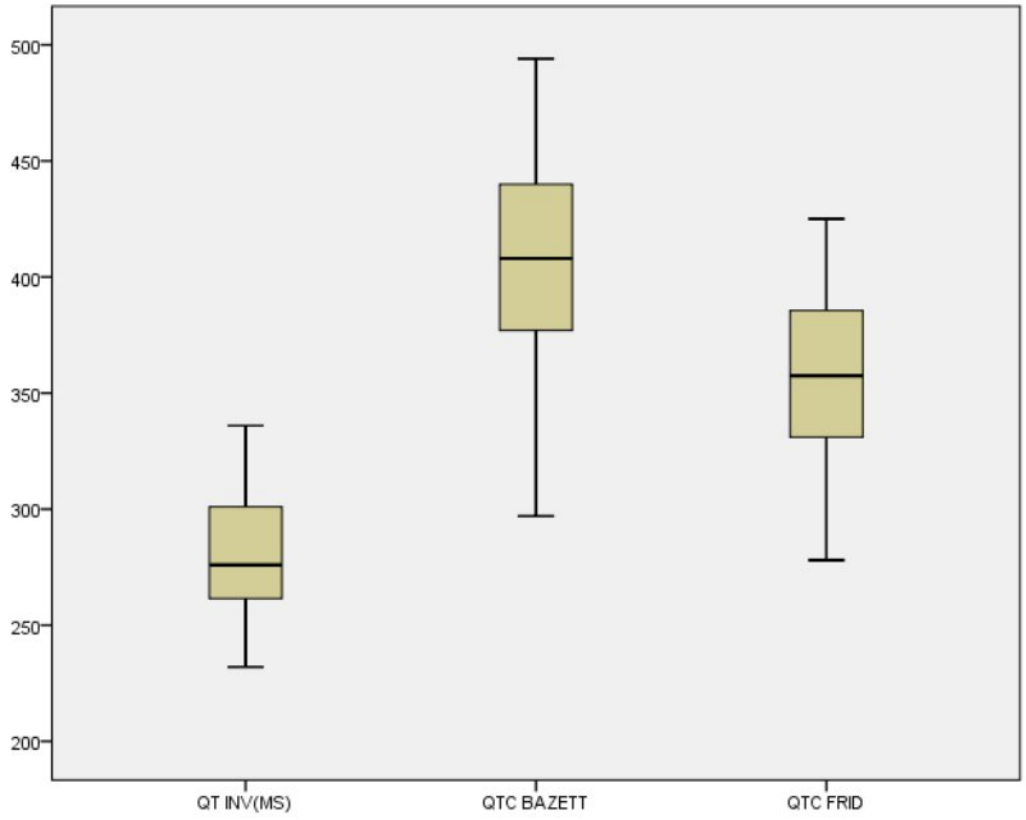


TABLE 12. QT INTERVAL, QTc -BAZETT,QTc FRIDERICIA BY Birth Weight

Descriptives

		N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean
						Lower Bound
QT INV(MS)	2 - 2.5 kg	9	312.67	10.920	3.640	304.27
	2.51 - 3 kg	28	277.93	25.351	4.791	268.10
	3.1 - 3.5 kg	32	272.72	21.218	3.751	265.07
	>3.5 kg	7	281.86	23.427	8.854	260.19
	Total	76	280.21	25.032	2.871	274.49
QTC BAZETT	2 - 2.5 kg	9	465.89	17.899	5.966	452.13
	2.51 - 3 kg	28	394.96	36.071	6.817	380.98
	3.1 - 3.5 kg	32	394.78	39.755	7.028	380.45
	>3.5 kg	7	418.86	28.410	10.738	392.58
	Total	76	405.49	42.013	4.819	395.89
QTC FRID	2 - 2.5 kg	9	402.22	24.672	8.224	383.26
	2.51 - 3 kg	28	350.54	30.897	5.839	338.56
	3.1 - 3.5 kg	32	348.50	31.069	5.492	337.30
	>3.5 kg	7	365.14	26.290	9.937	340.83
	Total	76	357.14	34.072	3.908	349.36

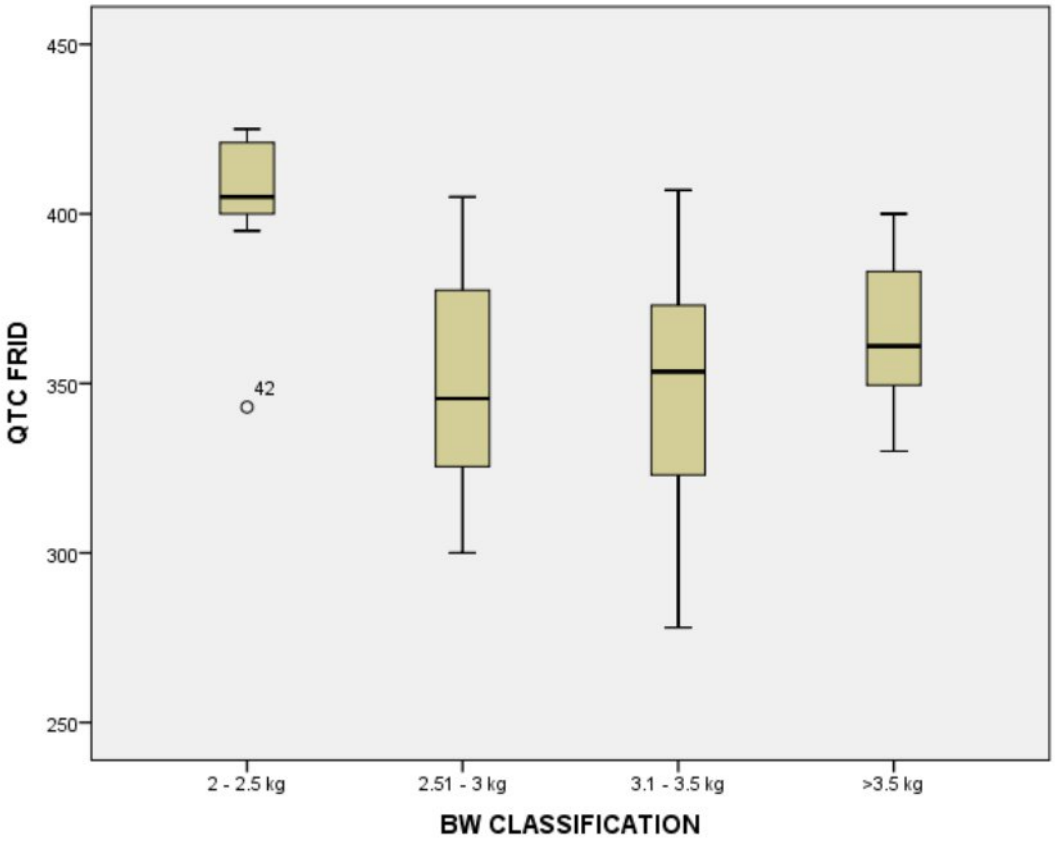
Descriptives

		95% Confidence Interval for Mean		
		Upper Bound	Minimum	Maximum
QT INV(MS)	2 - 2.5 kg	321.06	298	331
	2.51 - 3 kg	287.76	245	336
	3.1 - 3.5 kg	280.37	232	313
	>3.5 kg	303.52	244	322
	Total	285.93	232	336
QTC BAZETT	2 - 2.5 kg	479.65	444	494
	2.51 - 3 kg	408.95	324	451
	3.1 - 3.5 kg	409.11	297	472
	>3.5 kg	445.13	383	459
	Total	415.09	297	494
QTC FRID	2 - 2.5 kg	421.19	343	425
	2.51 - 3 kg	362.52	300	405
	3.1 - 3.5 kg	359.70	278	407
	>3.5 kg	389.46	330	400
	Total	364.93	278	425

The mean QTc inv calculated by both bazett and frideicia was higher in the 2-2.5 kg group and the difference between the groups was stastically significant p(0.000)

ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
QT INV(MS)	Between Groups	11441.449	3	3813.816	7.723	.000
	Within Groups	35555.183	72	493.822		
	Total	46996.632	75			
QTC BAZETT	Between Groups	40854.808	3	13618.269	10.712	.000
	Within Groups	91530.179	72	1271.252		
	Total	132384.987	75			
QTC FRID	Between Groups	22350.031	3	7450.010	8.289	.000
	Within Groups	64715.377	72	898.825		
	Total	87065.408	75			


450
400
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QTC FRID
42
2 - 2.5 kg
2.51 - 3 kg
3.1 - 3.5 kg
>3.5 kg
BW CLASSIFICATION

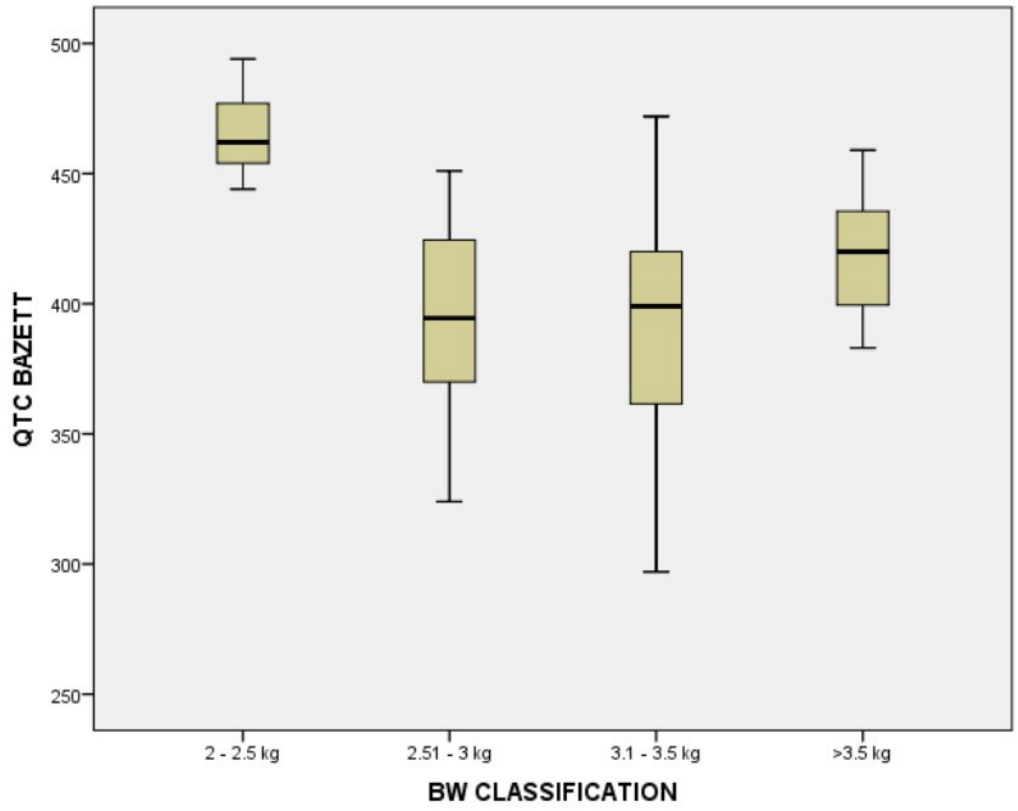


TABLE 13. QT INTERVAL, QTc -BAZETT,QTc FRIDERICIA BY GENDER

Group Statistics

	SEX	N	Mean	Std. Deviation	Std. Error Mean
QT INV(MS)	MALE	40	280.90	24.476	3.870
	FEMALE	36	279.44	25.963	4.327
QTC BAZETT	MALE	40	406.85	42.429	6.709
	FEMALE	36	403.97	42.095	7.016
QTC FRID	MALE	40	358.95	34.376	5.435
	FEMALE	36	355.14	34.102	5.684

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means	
		F	Sig.	t	df
QT INV(MS)	Equal variances assumed	.000	.989	.252	74
	Equal variances not assumed			.251	72.027
QTC BAZETT	Equal variances assumed	.594	.443	.296	74
	Equal variances not assumed			.296	73.283
QTC FRID	Equal variances assumed	.585	.447	.484	74
	Equal variances not assumed			.485	73.284

The difference in the QTc inv by both bazett and fridericia between the male and female new born is statistically not significant.

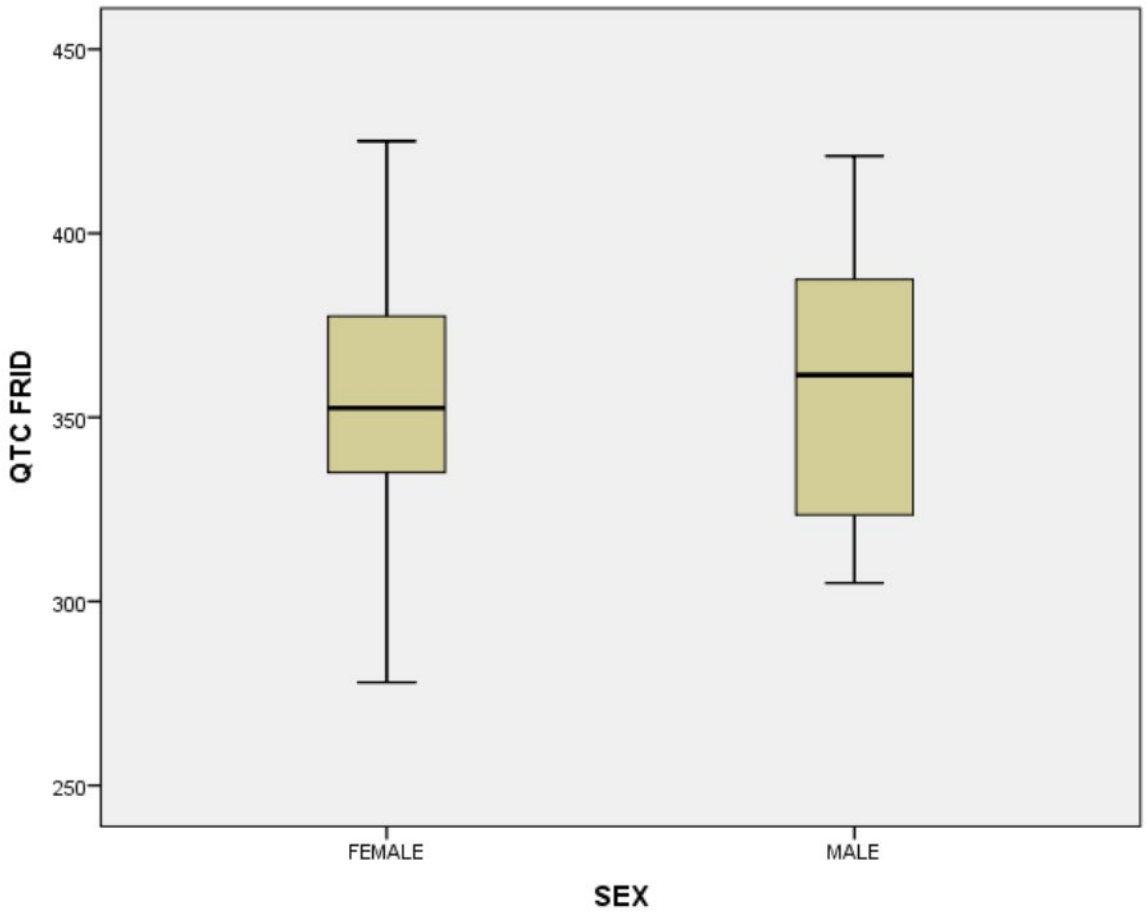
Independent Samples Test

		t-test for Equality of Means		
		Sig. (2-tailed)	Mean Difference	Std. Error Difference
QT INV(MS)	Equal variances assumed	.802	1.456	5.787
	Equal variances not assumed	.803	1.456	5.805
QTC BAZETT	Equal variances assumed	.768	2.878	9.711
	Equal variances not assumed	.768	2.878	9.707

QTC FRID	Equal variances assumed	.630	3.811	7.868
	Equal variances not assumed	.629	3.811	7.864

Independent Samples Test

		t-test for Equality of Means	
		95% Confidence Interval of the Difference	
		Lower	Upper
QT INV(MS)	Equal variances assumed	-10.075	12.987
	Equal variances not assumed	-10.117	13.028
QTC BAZETT	Equal variances assumed	-16.472	22.228
	Equal variances not assumed	-16.467	22.223
QTC FRID	Equal variances assumed	-11.866	19.488
	Equal variances not assumed	-11.861	19.484


450
400
350
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250
QTC FRID
FEMALE
MALE
SEX

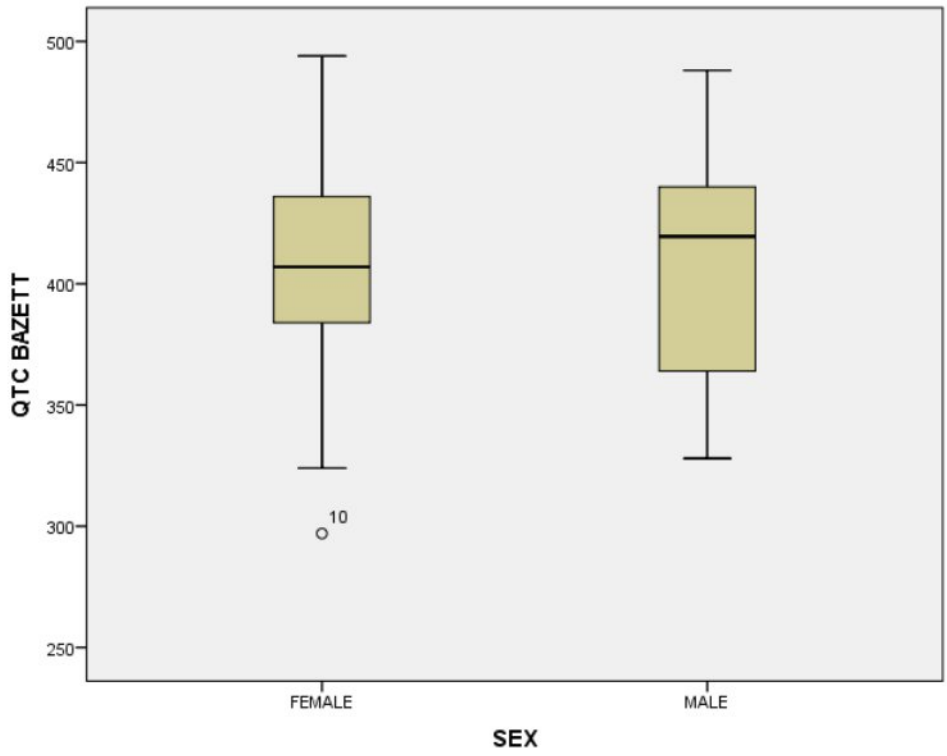


TABLE 14: P-AXIS, QRS-AXIS, T-AXIS BY AGE

Descriptives

		N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean
						Lower Bound
P AXIS	0-24 hrs	12	49.42	16.133	4.657	39.17
	25-48 hrs	46	43.26	13.384	1.973	39.29
	49-72 hrs	18	45.33	10.868	2.562	39.93
	Total	76	44.72	13.317	1.528	41.68
QRS AXIS	0-24 hrs	12	120.92	23.157	6.685	106.20

	25-48 hrs	46	116.15	16.294	2.402	111.31
	49-72 hrs	18	110.17	15.719	3.705	102.35
	Total	76	115.49	17.486	2.006	111.49
T AXIS	0-24 hrs	12	46.75	12.009	3.467	39.12
	25-48 hrs	46	37.17	13.203	1.947	33.25
	49-72 hrs	18	42.17	11.628	2.741	36.38
	Total	76	39.87	13.026	1.494	36.89

The mean p wave axis was 44.72 with sd of 13.37

The mean QRS wave axis was 115.49 with sd of 17.48

The mean T wave axis was 39.87 with sd of 13.026

Descriptives

		95% Confidence Interval for Mean		
		Upper Bound	Minimum	Maximum
P AXIS	0-24 hrs	59.67	21	75
	25-48 hrs	47.24	19	69
	49-72 hrs	50.74	35	76
	Total	47.77	19	76

QRS AXIS	0-24 hrs	135.63	91	165
	25-48 hrs	120.99	91	151
	49-72 hrs	117.98	75	139
	Total	119.48	75	165
T AXIS	0-24 hrs	54.38	34	68
	25-48 hrs	41.09	15	63
	49-72 hrs	47.95	21	56
	Total	42.85	15	68

		Sum of Squares	df	Mean Square	F	Sig.
P AXIS	Between Groups	369.411	2	184.706	1.043	.358
	Within Groups	12931.786	73	177.148		
	Total	13301.197	75			
QRS AXIS	Between Groups	883.635	2	441.818	1.463	.238
	Within Groups	22047.351	73	302.019		
	Total	22930.987	75			
T AXIS	Between Groups	997.326	2	498.663	3.104	.051

Within Groups	11729.359	73	160.676		
Total	12726.684	75			

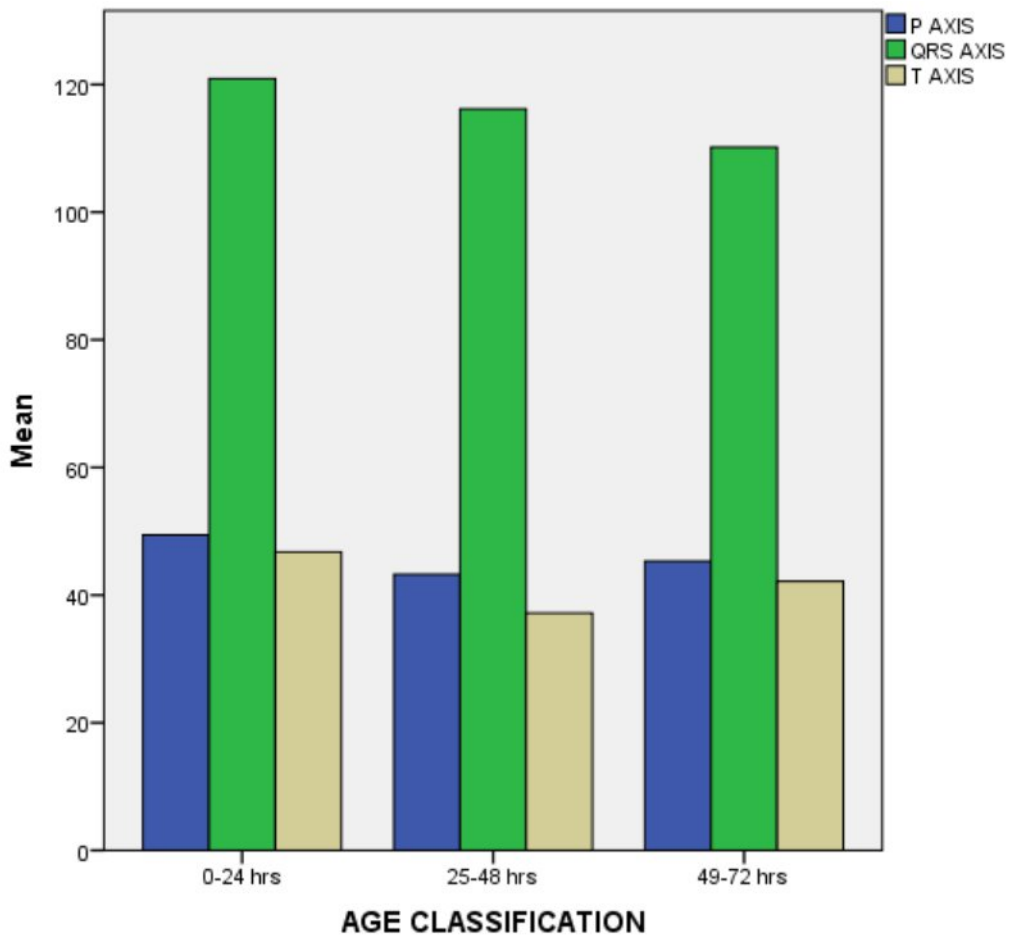


TABLE 15: P-AXIS, QRS-AXIS, T-AXIS BY BIRTH WT.

Descriptives

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean
					Lower Bound

P AXIS	2 - 2.5 kg	9	44.78	15.401	5.134	32.94
	2.51 - 3 kg	28	44.07	11.440	2.162	39.64
	3.1 - 3.5 kg	32	44.91	13.022	2.302	40.21
	>3.5 kg	7	46.43	20.735	7.837	27.25
	Total	76	44.72	13.317	1.528	41.68
QRS AXIS	2 - 2.5 kg	9	118.11	16.389	5.463	105.51
	2.51 - 3 kg	28	113.71	16.755	3.166	107.22
	3.1 - 3.5 kg	32	117.03	15.932	2.816	111.29
	>3.5 kg	7	112.14	28.951	10.942	85.37
	Total	76	115.49	17.486	2.006	111.49
T AXIS	2 - 2.5 kg	9	43.11	10.879	3.626	34.75
	2.51 - 3 kg	28	40.82	13.535	2.558	35.57
	3.1 - 3.5 kg	32	39.81	13.487	2.384	34.95
	>3.5 kg	7	32.14	10.463	3.955	22.47
	Total	76	39.87	13.026	1.494	36.89

Descriptives

	95% Confidence Interval for Mean		
	Upper Bound	Minimum	Maximum

P AXIS	2 - 2.5 kg	56.62	21	61
	2.51 - 3 kg	48.51	25	75
	3.1 - 3.5 kg	49.60	22	76
	>3.5 kg	65.61	19	75
	Total	47.77	19	76
QRS AXIS	2 - 2.5 kg	130.71	91	139
	2.51 - 3 kg	120.21	91	162
	3.1 - 3.5 kg	122.78	92	151
	>3.5 kg	138.92	75	165
	Total	119.48	75	165
T AXIS	2 - 2.5 kg	51.47	31	61
	2.51 - 3 kg	46.07	15	68
	3.1 - 3.5 kg	44.68	15	63
	>3.5 kg	41.82	21	45
	Total	42.85	15	68

The difference between the birth wt groups P,QRS,T wave axis as not statistically significant.

ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
P AXIS	Between Groups	33.352	3	11.117	.060	.980
	Within Groups	13267.846	72	184.276		
	Total	13301.197	75			
QRS AXIS	Between Groups	304.558	3	101.519	.323	.809
	Within Groups	22626.429	72	314.256		
	Total	22930.987	75			
T AXIS	Between Groups	537.956	3	179.319	1.059	.372
	Within Groups	12188.728	72	169.288		
	Total	12726.684	75			

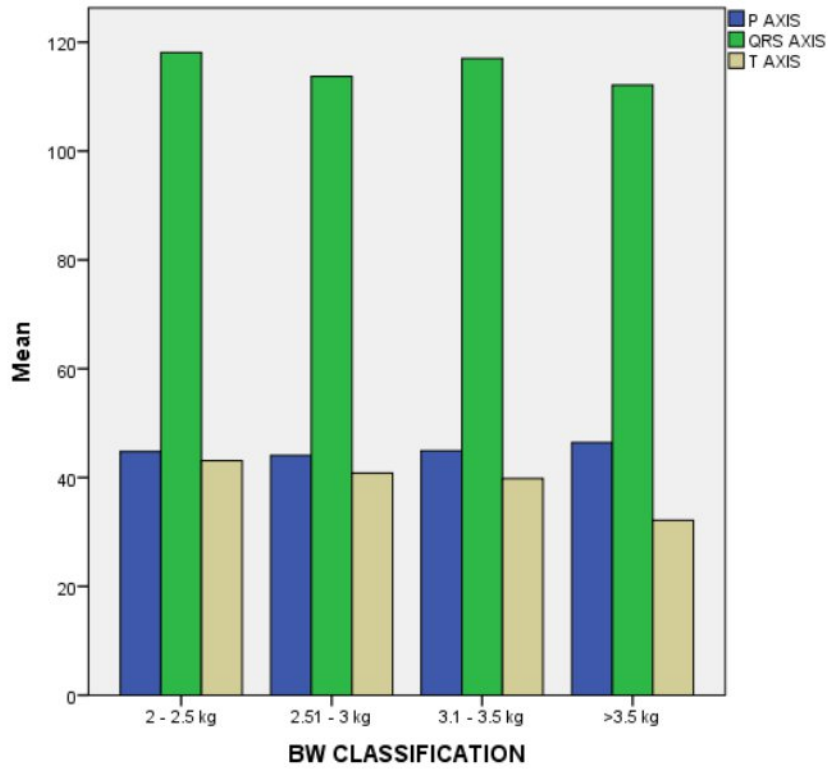


TABLE 16: P-AXIS, QRS-AXIS, T-AXIS BY GENDER

Group Statistics

	SEX	N	Mean	Std. Deviation	Std. Error Mean
P AXIS	MALE	40	45.30	13.215	2.089
	FEMALE	36	44.08	13.589	2.265
QRS AXIS	MALE	40	116.05	16.089	2.544
	FEMALE	36	114.86	19.130	3.188
T AXIS	MALE	40	40.78	12.456	1.969
	FEMALE	36	38.86	13.739	2.290

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means	
		F	Sig.	t	df
P AXIS	Equal variances assumed	.001	.972	.395	74
	Equal variances not assumed			.395	72.682
QRS AXIS	Equal variances assumed	1.095	.299	.294	74
	Equal variances not assumed			.291	68.745
T AXIS	Equal variances assumed	.818	.369	.637	74
	Equal variances not assumed			.634	71.046

Independent Samples Test

		t-test for Equality of Means			
		Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference
					Lower
P AXIS	Equal variances assumed	.694	1.217	3.077	-4.914
	Equal variances not assumed	.694	1.217	3.081	-4.925
QRS AXIS	Equal variances assumed	.769	1.189	4.042	-6.864
	Equal variances not assumed	.772	1.189	4.079	-6.949
T AXIS	Equal variances assumed	.526	1.914	3.005	-4.073
	Equal variances not assumed	.528	1.914	3.020	-4.108

		t-test for Equality of Means
		95% Confidence Interval of the Difference
		Upper
P AXIS	Equal variances assumed	7.347
	Equal variances not assumed	7.358
QRS AXIS	Equal variances assumed	9.242
	Equal variances not assumed	9.327
T AXIS	Equal variances assumed	7.901
	Equal variances not assumed	7.936

There was no statistical differnce bteween gender in P,QRS,T wave axis

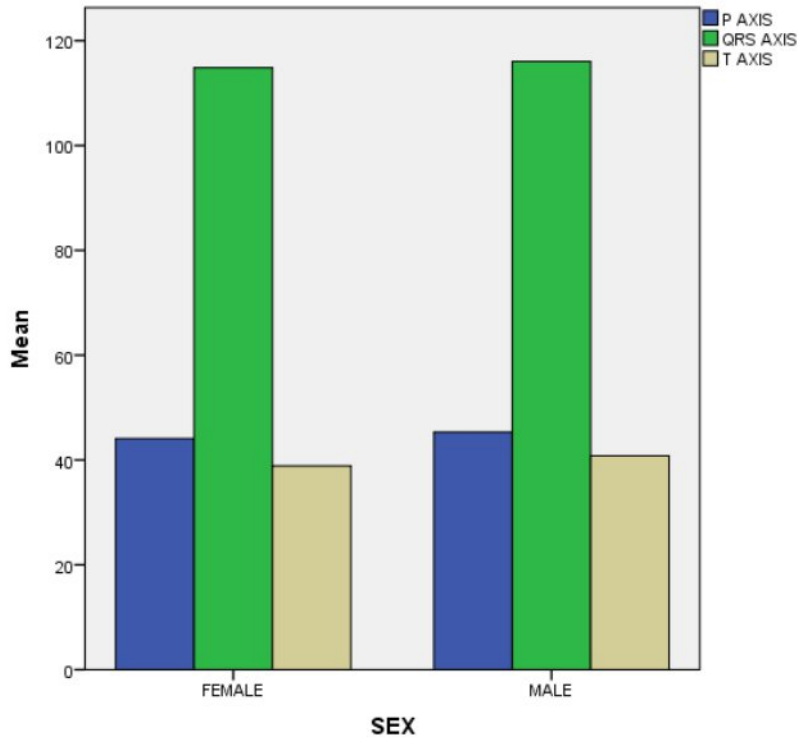


TABLE 17: R WAVE AMPLITUDE IN V1,S WAVE AMPLITUDE IN V6, RV1+SV6 BY AGE

Descriptives

		N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean
						Lower Bound
R V1(MM)	0-24 hrs	12	15.33	2.229	.644	13.92
	25-48 hrs	46	12.14	1.576	.232	11.67
	49-72 hrs	18	7.56	.984	.232	7.07

	Total	76	11.56	2.962	.340	10.88
SV6(MM)	0-24 hrs	12	4.17	1.801	.520	3.02
	25-48 hrs	46	3.89	1.577	.233	3.42
	49-72 hrs	18	2.42	1.141	.269	1.85
	Total	76	3.59	1.644	.189	3.21
RV1+SV6	0-24 hrs	12	19.50	3.398	.981	17.34
	25-48 hrs	46	16.03	2.291	.338	15.35
	49-72 hrs	18	9.97	1.356	.319	9.30
	Total	76	15.14	3.899	.447	14.25

Descriptives

		95% Confidence Interval for Mean		
		Upper Bound	Minimum	Maximum
R V1(MM)	0-24 hrs	16.75	10	18
	25-48 hrs	12.61	9	15
	49-72 hrs	8.04	6	9
	Total	12.24	6	18
SV6(MM)	0-24 hrs	5.31	1	7

	25-48 hrs	4.36	0	7
	49-72 hrs	2.98	1	4
	Total	3.96	0	7
RV1+SV6	0-24 hrs	21.66	11	22
	25-48 hrs	16.71	12	21
	49-72 hrs	10.65	7	12
	Total	16.04	7	22

The mean R wave amplitude in 0-24 hrs group was 15.33mm.

The mean R wave amplitude in 25-48 hrs group was 12.14mm.

The mean R wave amplitude in 49-72hrs group was 7.56 mm.

This shows the gradual regression of amplitude of the R wave with time and it is statistically significant p(0.000).

During the 72 hrs period there is also the regression of the s wave amplitude in lead v6 which is also statistically significant.

ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
R V1(MM)	Between Groups	475.041	2	237.520	94.778	.000
	Within Groups	182.943	73	2.506		
	Total	657.984	75			
SV6(MM)	Between Groups	32.946	2	16.473	7.084	.002
	Within Groups	169.748	73	2.325		
	Total	202.694	75			
RV1+SV6	Between Groups	745.471	2	372.735	68.984	.000
	Within Groups	394.437	73	5.403		
	Total	1139.908	75			

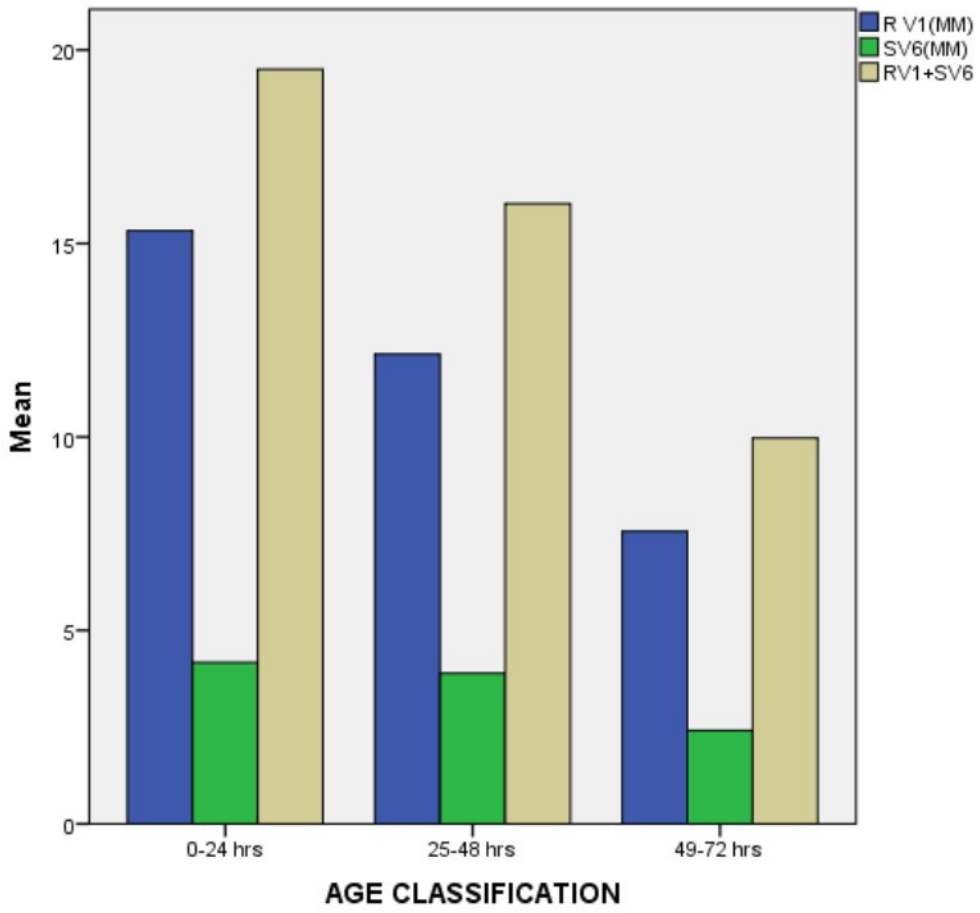

R V1(MM)
SV6(MM)
RV1+SV6
Mean
20
15
10
5
0
0-24 hrs
25-48 hrs
49-72 hrs
AGE CLASSIFICATION

TABLE 18: R WAVE AMPLITUDE IN V1,S WAVE AMPLITUDE IN V6, RV1+SV6 BYBIRTH WT

Descriptives

		N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean
						Lower Bound
R V1(MM)	2 - 2.5 kg	9	12.56	2.404	.801	10.71
	2.51 - 3 kg	28	11.54	3.274	.619	10.27
	3.1 - 3.5 kg	32	11.06	2.940	.520	10.00
	>3.5 kg	7	12.64	2.212	.836	10.60
	Total	76	11.56	2.962	.340	10.88
SV6(MM)	2 - 2.5 kg	9	4.11	1.167	.389	3.21
	2.51 - 3 kg	28	3.41	1.939	.366	2.66
	3.1 - 3.5 kg	32	3.61	1.418	.251	3.10
	>3.5 kg	7	3.50	2.021	.764	1.63
	Total	76	3.59	1.644	.189	3.21
RV1+SV6	2 - 2.5 kg	9	16.67	3.162	1.054	14.24
	2.51 - 3 kg	28	14.95	4.450	.841	13.22
	3.1 - 3.5 kg	32	14.67	3.724	.658	13.33
	>3.5 kg	7	16.14	3.145	1.189	13.23
	Total	76	15.14	3.899	.447	14.25

Descriptives

		95% Confidence Interval for Mean		
		Upper Bound	Minimum	Maximum
R V1(MM)	2 - 2.5 kg	14.40	10	16
	2.51 - 3 kg	12.81	6	18
	3.1 - 3.5 kg	12.12	6	16
	>3.5 kg	14.69	8	15
	Total	12.24	6	18
SV6(MM)	2 - 2.5 kg	5.01	2	6
	2.51 - 3 kg	4.16	0	7
	3.1 - 3.5 kg	4.12	1	7
	>3.5 kg	5.37	1	6
	Total	3.96	0	7
RV1+SV6	2 - 2.5 kg	19.10	12	22
	2.51 - 3 kg	16.67	7	22
	3.1 - 3.5 kg	16.01	9	22
	>3.5 kg	19.05	12	21
	Total	16.04	7	22

There is no statistically difference in the mean values withinthe groups.

ANOVA		Sum of Squares	df	Mean Square	F	Sig.
R V1(MM)	Between Groups	25.065	3	8.355	.950	.421
	Within Groups	632.919	72	8.791		
	Total	657.984	75			
SV6(MM)	Between Groups	3.411	3	1.137	.411	.746
	Within Groups	199.283	72	2.768		
	Total	202.694	75			
RV1+SV6	Between Groups	36.076	3	12.025	.784	.507
	Within Groups	1103.831	72	15.331		
	Total	1139.908	75			

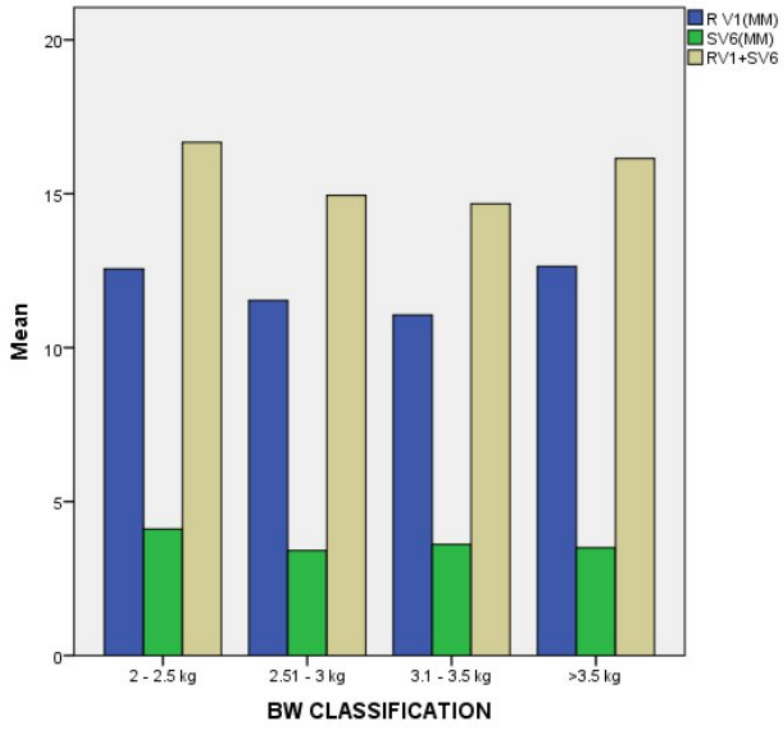


TABLE 19: R WAVE AMPLITUDE IN V1, S WAVE AMPLITUDE IN V6, RV1+SV6 BY GENDER

Group Statistics

	SEX	N	Mean	Std. Deviation	Std. Error Mean
R V1(MM)	MALE	40	11.59	3.067	.485
	FEMALE	36	11.53	2.883	.481
SV6(MM)	MALE	40	3.69	1.426	.226

	FEMALE	36	3.47	1.871	.312
RV1+SV6	MALE	40	15.28	3.863	.611
	FEMALE	36	15.00	3.987	.665

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means	
		F	Sig.	t	df
R V1(MM)	Equal variances assumed	.022	.883	.087	74
	Equal variances not assumed			.087	73.851
SV6(MM)	Equal variances assumed	2.686	.105	.567	74
	Equal variances not assumed			.559	65.192
RV1+SV6	Equal variances assumed	.138	.711	.305	74
	Equal variances not assumed			.305	72.608

Independent Samples Test

		t-test for Equality of Means			
		Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference
					Lower
R V1(MM)	Equal variances assumed	.931	.060	.685	-1.305

	Equal variances not assumed	.931	.060	.683	-1.301
SV6(MM)	Equal variances assumed	.572	.215	.379	-.541
	Equal variances not assumed	.578	.215	.385	-.553
RV1+SV6	Equal variances assumed	.761	.275	.901	-1.520
	Equal variances not assumed	.761	.275	.903	-1.524

Independent Samples Test

		t-test for Equality of Means
		95% Confidence Interval of the Difference
		Upper
R V1(MM)	Equal variances assumed	1.425
	Equal variances not assumed	1.420
SV6(MM)	Equal variances assumed	.971
	Equal variances not assumed	.984
RV1+SV6	Equal variances assumed	2.070
	Equal variances not assumed	2.074

The mean R wave amplitude in V1 among male and the female newborn were 11.59 &11.53 respectively but it is statisticlly not significant. there is also no statistical difference in the s wave amplitude of the male and female newborn in the leadV6

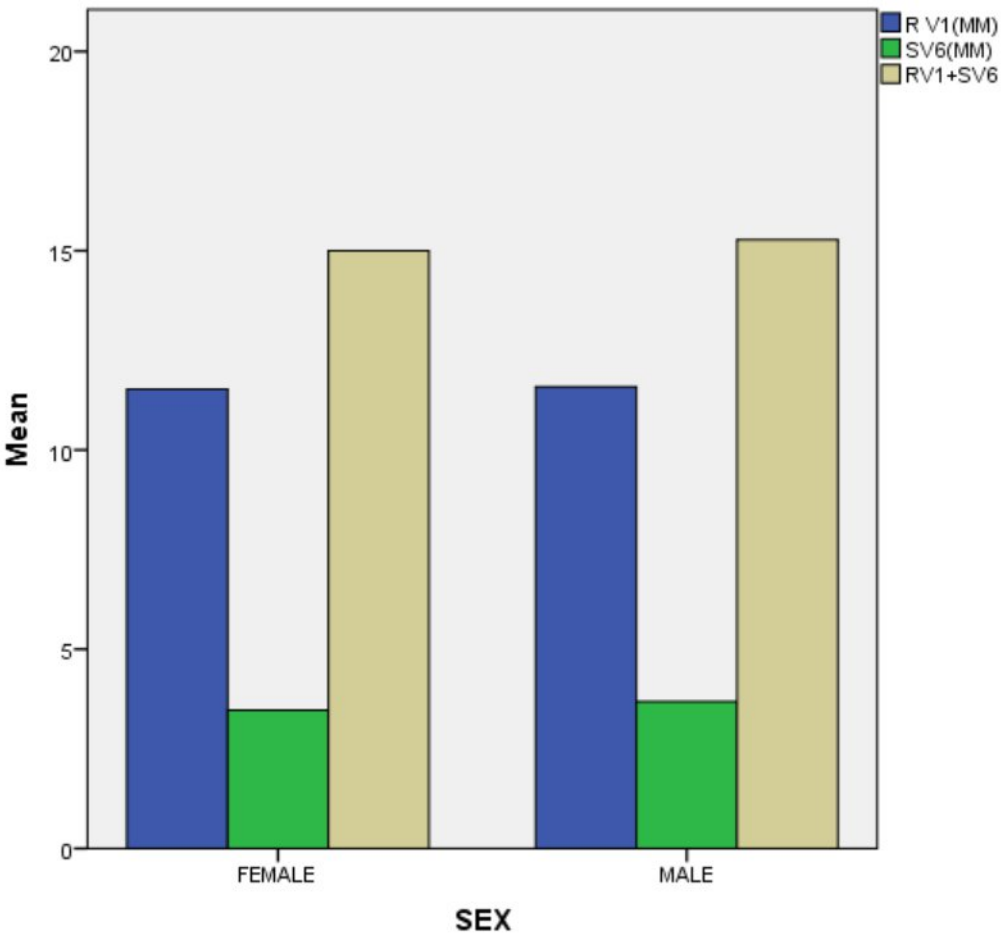


TABLE 20: R WAVE AMPLITUDE IN V6, S WAVE AMPLITUDE IN V1, RV6+SV1 BY AGE

Descriptives

		N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean
						Lower Bound
RV6(MM)	0-24 hrs	12	4.83	1.586	.458	3.83
	25-48 hrs	46	5.40	2.170	.320	4.76
	49-72 hrs	18	3.31	1.202	.283	2.71
	Total	76	4.82	2.069	.237	4.34
SV1(MM)	0-24 hrs	12	2.67	1.557	.449	1.68
	25-48 hrs	46	2.57	1.377	.203	2.16
	49-72 hrs	18	2.04	1.064	.251	1.51
	Total	76	2.46	1.344	.154	2.15
RV6+SV1	0-24 hrs	12	7.50	1.679	.485	6.43
	25-48 hrs	46	7.97	1.851	.273	7.42
	49-72 hrs	18	5.34	2.195	.517	4.25
	Total	76	7.27	2.181	.250	6.77

Descriptives

	95% Confidence Interval for Mean	Minimum	Maximum

		Upper Bound		
RV6(MM)	0-24 hrs	5.84	1	7
	25-48 hrs	6.05	2	11
	49-72 hrs	3.90	2	6
	Total	5.29	1	11
SV1(MM)	0-24 hrs	3.66	1	6
	25-48 hrs	2.97	1	6
	49-72 hrs	2.57	1	4
	Total	2.76	1	6
RV6+SV1	0-24 hrs	8.57	5	11
	25-48 hrs	8.52	4	14
	49-72 hrs	6.44	3	10
	Total	7.77	3	14

The mean R wave amplitude in V6 was 4.82mm with the sd of 2.069mm with 95% CI for mean lower bound 4.34 and mean upper bound 5.29. The difference between the groups was statistically significant with p 0.001

ANOVA		Sum of Squares	df	Mean Square	F	Sig.
RV6(MM)	Between Groups	56.875	2	28.438	7.862	.001
	Within Groups	264.046	73	3.617		
	Total	320.921	75			
SV1(MM)	Between Groups	4.213	2	2.106	1.172	.316
	Within Groups	131.234	73	1.798		
	Total	135.447	75			
RV6+SV1	Between Groups	89.746	2	44.873	12.264	.000
	Within Groups	267.106	73	3.659		
	Total	356.852	75			

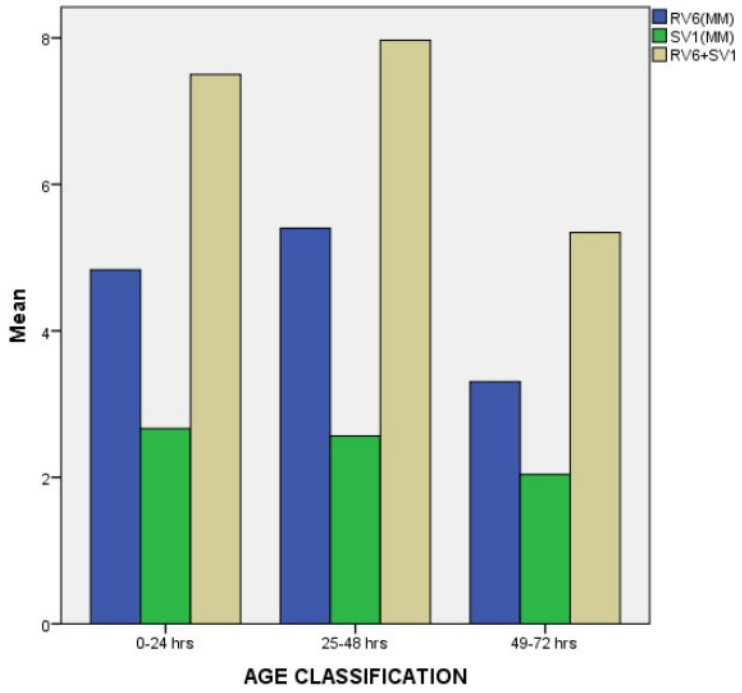


TABLE 21: R WAVE AMPLITUDE IN V6, S WAVE AMPLITUDE IN V1, RV6+SV1 BY BIRTH WT.

Descriptives

		N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean
						Lower Bound
RV6(MM)	2 - 2.5 kg	9	6.00	1.500	.500	4.85

	2.51 - 3 kg	28	4.88	2.201	.416	4.02
	3.1 - 3.5 kg	32	4.52	2.093	.370	3.76
	>3.5 kg	7	4.43	1.813	.685	2.75
	Total	76	4.82	2.069	.237	4.34
SV1(MM)	2 - 2.5 kg	9	3.00	2.000	.667	1.46
	2.51 - 3 kg	28	2.59	1.327	.251	2.07
	3.1 - 3.5 kg	32	2.19	1.091	.193	1.79
	>3.5 kg	7	2.46	1.504	.569	1.07
	Total	76	2.46	1.344	.154	2.15
RV6+SV1	2 - 2.5 kg	9	9.00	1.414	.471	7.91
	2.51 - 3 kg	28	7.46	2.442	.461	6.52
	3.1 - 3.5 kg	32	6.70	2.051	.363	5.96
	>3.5 kg	7	6.89	1.301	.492	5.68
	Total	76	7.27	2.181	.250	6.77

Descriptives

		95% Confidence Interval for Mean		
		Upper Bound	Minimum	Maximum
RV6(MM)	2 - 2.5 kg	7.15	4	9
	2.51 - 3 kg	5.73	2	11
	3.1 - 3.5 kg	5.27	1	9
	>3.5 kg	6.10	2	7
	Total	5.29	1	11

SV1(MM)	2 - 2.5 kg	4.54	1	6
	2.51 - 3 kg	3.10	1	6
	3.1 - 3.5 kg	2.58	1	5
	>3.5 kg	3.85	1	5
	Total	2.76	1	6
RV6+SV1	2 - 2.5 kg	10.09	7	11
	2.51 - 3 kg	8.41	3	14
	3.1 - 3.5 kg	7.44	3	11
	>3.5 kg	8.09	5	9
	Total	7.77	3	14

Though the R wave amplitude is higher in the 2-2.5 kg group it is statistically not significant

ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
RV6(MM)	Between Groups	16.652	3	5.551	1.313	.277
	Within Groups	304.269	72	4.226		
	Total	320.921	75			
SV1(MM)	Between Groups	5.468	3	1.823	1.010	.394

	Within Groups	129.979	72	1.805		
	Total	135.447	75			
RV6+SV1	Between Groups	39.309	3	13.103	2.971	.037
	Within Groups	317.543	72	4.410		
	Total	356.852	75			

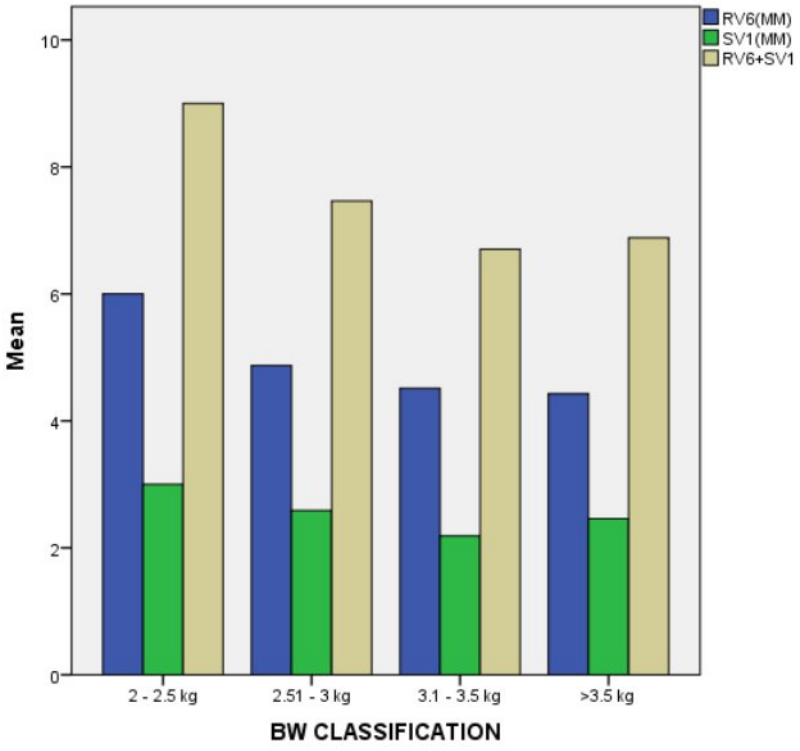


TABLE 22: R WAVE AMPLITUDE IN V6, S WAVE AMPLITUDE IN V1, RV6+SV1 BY GENDER

Group Statistics

	SEX	N	Mean	Std. Deviation	Std. Error Mean
RV6(MM)	MALE	40	4.66	1.886	.298
	FEMALE	36	4.99	2.269	.378
SV1(MM)	MALE	40	2.50	1.320	.209
	FEMALE	36	2.41	1.387	.231
RV6+SV1	MALE	40	7.16	2.150	.340
	FEMALE	36	7.39	2.240	.373

Independent Samples Test

	Levene's Test for Equality of Variances	t-test for Equality of Means

		F	Sig.	t	df
RV6(MM)	Equal variances assumed	.212	.646	-.679	74
	Equal variances not assumed			-.672	68.336
SV1(MM)	Equal variances assumed	.713	.401	.295	74
	Equal variances not assumed			.294	72.254
RV6+SV1	Equal variances assumed	.177	.676	-.460	74
	Equal variances not assumed			-.459	72.414

Independent Samples Test

		t-test for Equality of Means			
					95% Confidence Interval of the Difference
		Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower
RV6(MM)	Equal variances assumed	.500	-.324	.477	-1.274
	Equal variances not assumed	.504	-.324	.482	-1.285
SV1(MM)	Equal variances assumed	.769	.092	.311	-.527
	Equal variances not assumed	.769	.092	.311	-.529
RV6+SV1	Equal variances assumed	.647	-.232	.504	-1.236
	Equal variances not assumed	.647	-.232	.505	-1.238

Independent Samples Test

		t-test for Equality of Means
		95% Confidence Interval of the Difference
		Upper
RV6(MM)	Equal variances assumed	.627
	Equal variances not assumed	.637
SV1(MM)	Equal variances assumed	.711
	Equal variances not assumed	.712
RV6+SV1	Equal variances assumed	.772
	Equal variances not assumed	.774

There was no significant difference between R wave amplitude,S wave amplitude between the age groups.

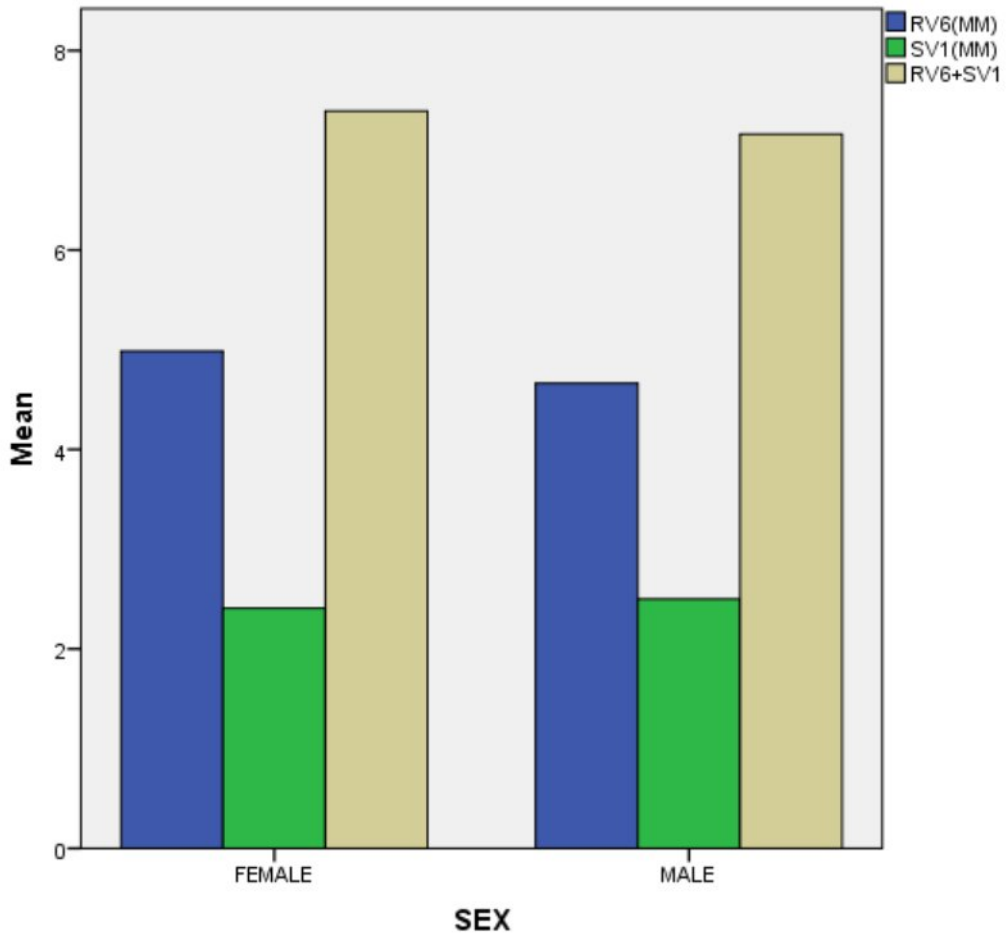


TABLE 23:V1 (R/S) BY AGE

Descriptives

V1(R/S)

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean	
					Lower Bound	Upper Bound
0-24 hrs	12	8.12	5.026	1.451	4.92	11.31
25-48 hrs	46	6.51	4.064	.599	5.30	7.72
49-72 hrs	18	4.61	2.091	.493	3.57	5.65
Total	76	6.31	3.981	.457	5.40	7.22

Descriptives

V1(R/S)

	Minimum	Maximum
0-24 hrs	3	16
25-48 hrs	2	15
49-72 hrs	2	8
Total	2	16

ANOVA

V1(R/S)

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	93.237	2	46.618	3.106	.051
Within Groups	1095.558	73	15.008		
Total	1188.794	75			

The mean V1(R/S) ratio observed was 6.31 with s d of 3.981

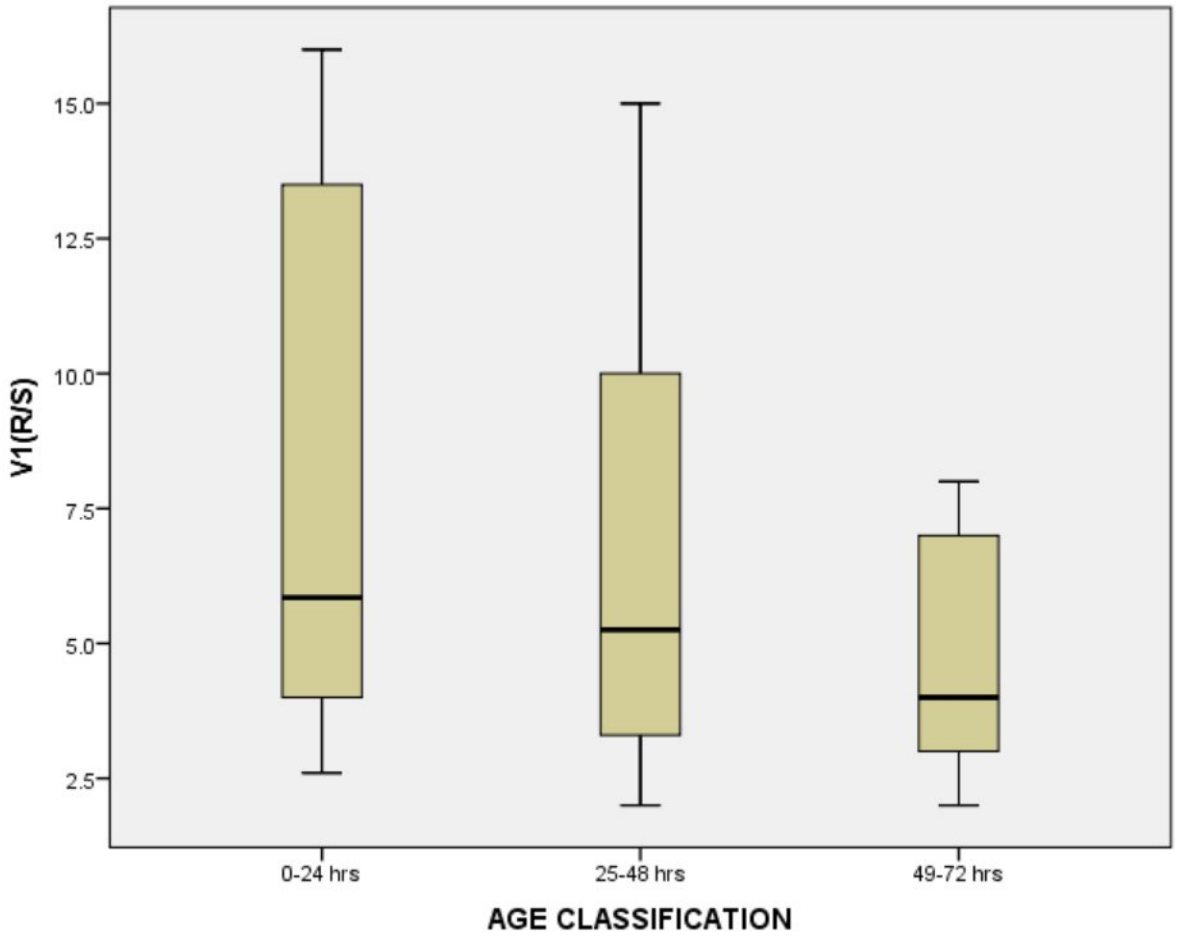

15.0
12.5
10.0
7.5
5.0
2.5
V1(R/S)
0-24 hrs
25-48 hrs
49-72 hrs
AGE CLASSIFICATION

TABLE 24:V1 (R/S) BY BIRTH WEIGHT

Descriptives

V1(R/S)

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean	
					Lower Bound	Upper Bound
2 - 2.5 kg	9	6.37	4.467	1.489	2.94	9.81
2.51 - 3 kg	28	5.93	3.854	.728	4.43	7.42
3.1 - 3.5 kg	32	6.43	3.903	.690	5.02	7.84
>3.5 kg	7	7.24	4.921	1.860	2.69	11.79
Total	76	6.31	3.981	.457	5.40	7.22

Descriptives

V1(R/S)

	Minimum	Maximum
2 - 2.5 kg	2	14
2.51 - 3 kg	2	15
3.1 - 3.5 kg	2	16
>3.5 kg	3	15
Total	2	16

ANOVA

V1(R/S)

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	10.645	3	3.548	.217	.884
Within Groups	1178.150	72	16.363		
Total	1188.794	75			

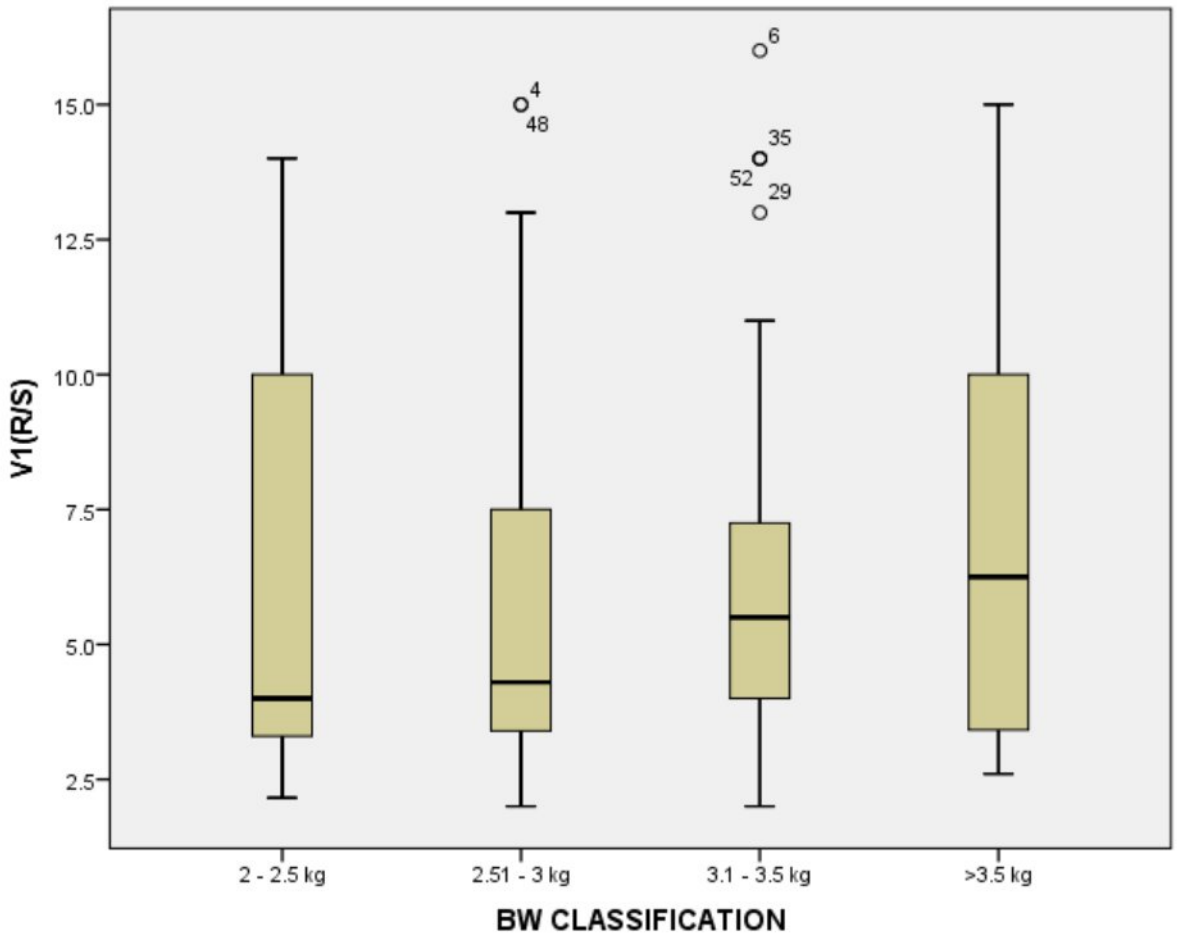


TABLE 25:V1 (R/S) BY GENDER

Group Statistics

	SEX	N	Mean	Std. Deviation	Std. Error Mean
V1(R/S)	MALE	40	5.95	3.685	.583
	FEMALE	36	6.72	4.303	.717

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means	
		F	Sig.	t	df
V1(R/S)	Equal variances assumed	2.445	.122	-.840	74
	Equal variances not assumed			-.833	69.340

Independent Samples Test

		t-test for Equality of Means			
		Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference
					Lower
V1(R/S)	Equal variances assumed	.404	-.770	.916	-2.596
	Equal variances not assumed	.408	-.770	.924	-2.613

Independent Samples Test

		t-test for Equality of Means
		95% Confidence Interval of the Difference
		Upper
V1(R/S)	Equal variances assumed	1.056
	Equal variances not assumed	1.073

The mean V1(R/S) observed among males and the feamale newborn are 5.95 and 6.72 respectively.

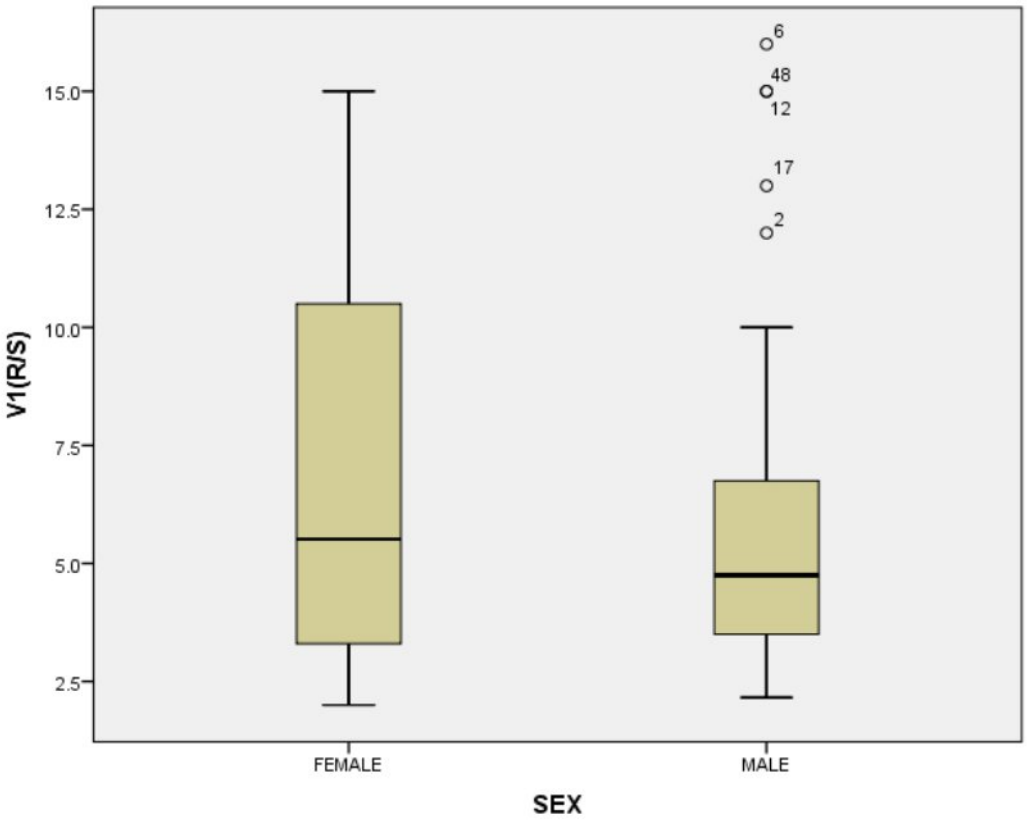


TABLE 26:Q III AND Q V6 AMPLITUDE BY AGE

Descriptives

		N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean
						Lower Bound
QIII(MM)	0-24 hrs	12	1.67	.807	.233	1.15
	25-48 hrs	46	1.63	.582	.086	1.46
	49-72 hrs	18	1.67	.343	.081	1.50
	Total	76	1.64	.570	.065	1.51
QV6(MM)	0-24 hrs	12	.625	.2261	.0653	.481
	25-48 hrs	46	.734	.3180	.0469	.639
	49-72 hrs	18	.628	.2164	.0510	.520
	Total	76	.691	.2856	.0328	.626

Descriptives

		95% Confidence Interval for Mean	Minimum	Maximum
		Upper Bound		
QIII(MM)	0-24 hrs	2.18	1	3
	25-48 hrs	1.80	1	3
	49-72 hrs	1.84	1	2
	Total	1.78	1	3
QV6(MM)	0-24 hrs	.769	.5	1.0
	25-48 hrs	.828	.3	1.5
	49-72 hrs	.735	.5	1.0

Total	.757	.3	1.5

The mean Q wave amplitude in leadIII and V6 are 1.64 and 0.691 respectively

ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
QIII(MM)	Between Groups	.024	2	.012	.036	.965
	Within Groups	24.384	73	.334		
	Total	24.408	75			
QV6(MM)	Between Groups	.208	2	.104	1.285	.283
	Within Groups	5.909	73	.081		
	Total	6.117	75			

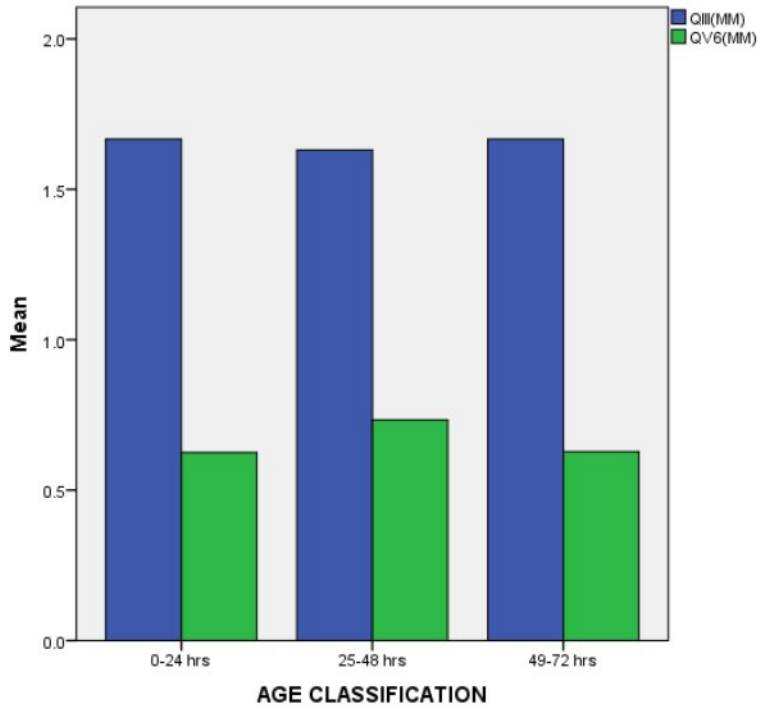


TABLE 27:Q III AND Q V6 AMPLITUDE BY BIRTH WT

Descriptives

		N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean
						Lower Bound
QIII(MM)	2 - 2.5 kg	9	1.83	.750	.250	1.26
	2.51 - 3 kg	28	1.61	.614	.116	1.37
	3.1 - 3.5 kg	32	1.61	.453	.080	1.45
	>3.5 kg	7	1.71	.699	.264	1.07
	Total	76	1.64	.570	.065	1.51
QV6(MM)	2 - 2.5 kg	9	.611	.2205	.0735	.442

	2.51 - 3 kg	28	.696	.2835	.0536	.587
	3.1 - 3.5 kg	32	.695	.3158	.0558	.581
	>3.5 kg	7	.757	.2507	.0948	.525
	Total	76	.691	.2856	.0328	.626

Descriptives

		95% Confidence Interval for Mean		
		Upper Bound	Minimum	Maximum
QIII(MM)	2 - 2.5 kg	2.41	1	3
	2.51 - 3 kg	1.85	1	3
	3.1 - 3.5 kg	1.77	1	2
	>3.5 kg	2.36	1	3
	Total	1.78	1	3
QV6(MM)	2 - 2.5 kg	.781	.5	1.0
	2.51 - 3 kg	.806	.5	1.5
	3.1 - 3.5 kg	.809	.3	1.5
	>3.5 kg	.989	.5	1.0
	Total	.757	.3	1.5

ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
QIII(MM)	Between Groups	.434	3	.145	.434	.729
	Within Groups	23.974	72	.333		

	Total	24.408	75			
QV6(MM)	Between Groups	.089	3	.030	.356	.785
	Within Groups	6.027	72	.084		
	Total	6.117	75			

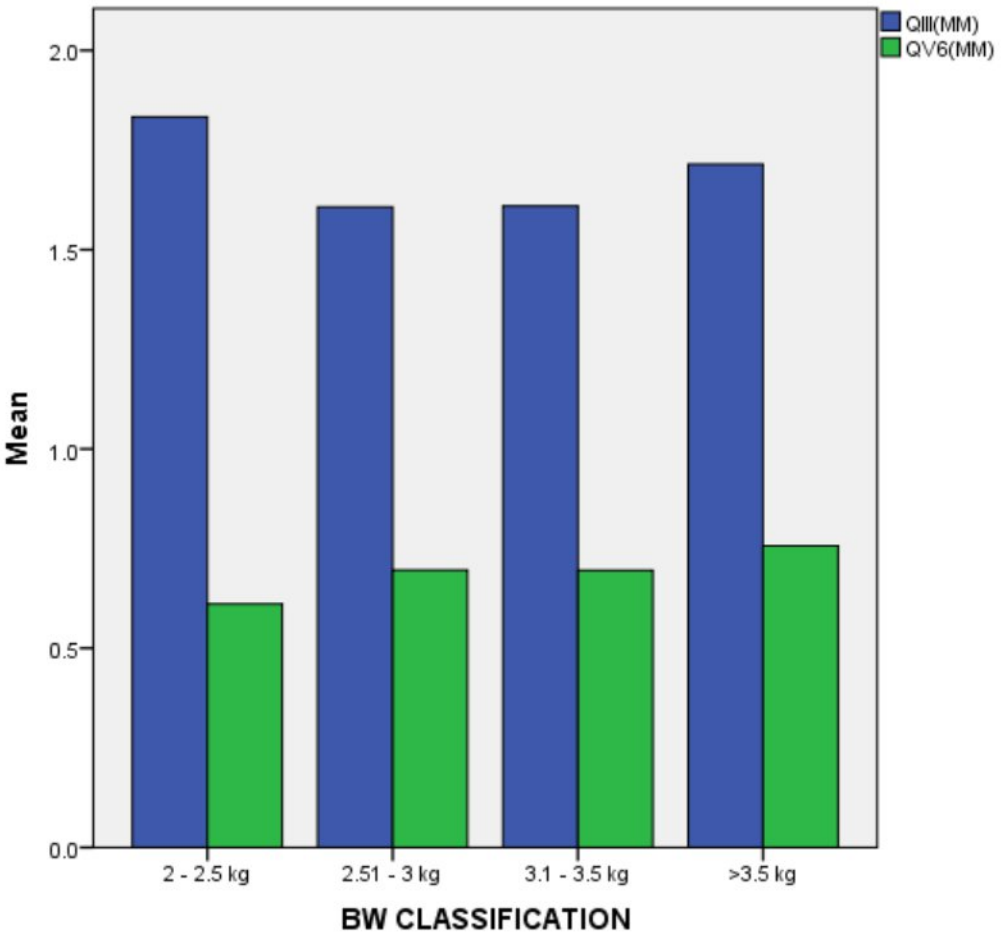


TABLE 28:Q III AND Q V6 AMPLITUDE BY GENDER

Group Statistics

	SEX	N	Mean	Std. Deviation	Std. Error Mean
QIII(MM)	MALE	40	1.60	.632	.100
	FEMALE	36	1.69	.497	.083
QV6(MM)	MALE	40	.706	.3247	.0513
	FEMALE	36	.675	.2383	.0397

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means	
		F	Sig.	t	df
QIII(MM)	Equal variances assumed	1.016	.317	-.718	74
	Equal variances not assumed			-.727	72.721

QV6(MM)	Equal variances assumed	3.969	.050	.474	74
	Equal variances not assumed			.481	71.226

Independent Samples Test

		t-test for Equality of Means			
					95% Confidence Interval of the Difference
		Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower
QIII(MM)	Equal variances assumed	.475	-.094	.131	-.356
	Equal variances not assumed	.469	-.094	.130	-.353
QV6(MM)	Equal variances assumed	.637	.0313	.0660	-.1002
	Equal variances not assumed	.632	.0313	.0649	-.0982

Independent Samples Test

		t-test for Equality of Means
		95% Confidence Interval of the Difference
		Upper
QIII(MM)	Equal variances assumed	.168
	Equal variances not assumed	.164
QV6(MM)	Equal variances assumed	.1627
	Equal variances not assumed	.1607

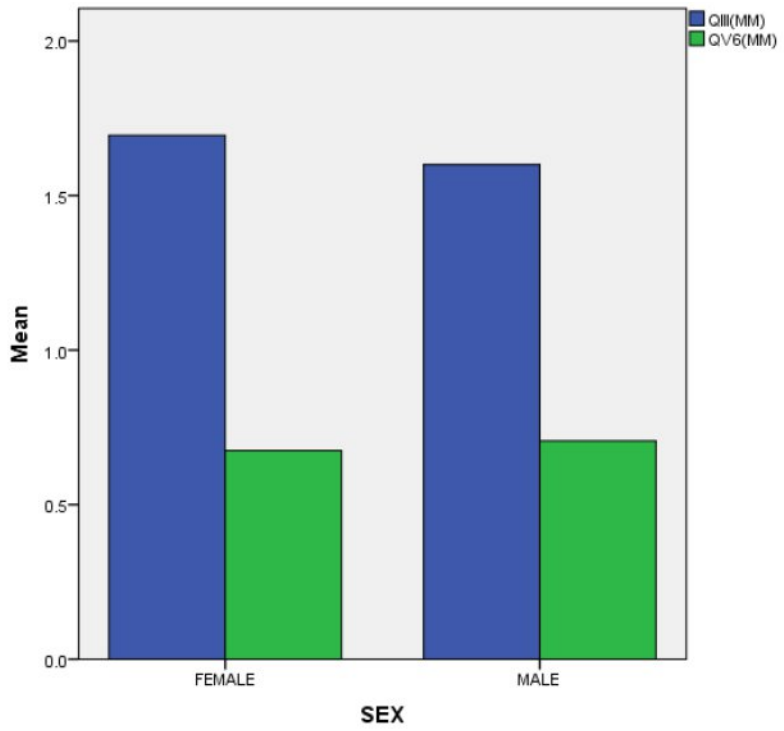


TABLE 29: T WAVE AMPLITUDE BY AGE

Descriptives

TV1(MM)

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean	
					Lower Bound	Upper Bound
0-24 hrs	12	.000	.8528	.2462	-.542	.542
25-48 hrs	46	.272	.9111	.1343	.001	.542
49-72 hrs	18	-.194	.9097	.2144	-.647	.258
Total	76	.118	.9124	.1047	-.090	.327

Descriptives

TV1(MM)

	Minimum	Maximum

0-24 hrs	-1.0	1.0
25-48 hrs	-2.0	2.0
49-72 hrs	-1.0	2.0
Total	-2.0	2.0

ANOVA

TV1(MM)

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	3.012	2	1.506	1.850	.165
Within Groups	59.423	73	.814		
Total	62.434	75			

The mean T wave amplitude noted in V1 is 0.118mm with sd of 0.91

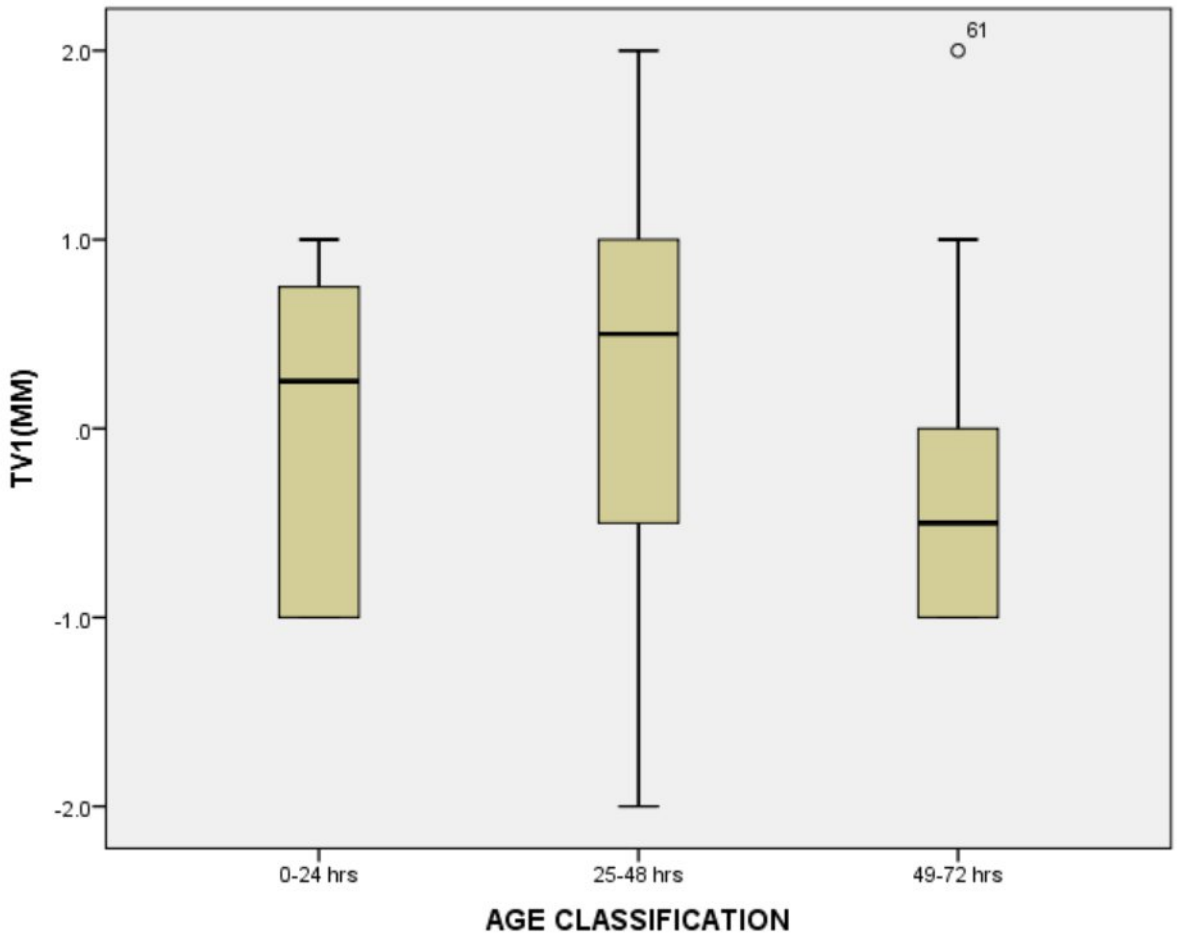


TABLE 30: T WAVE AMPLITUDE BY BIRTH WT

Descriptives

TV1(MM)

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean	
					Lower Bound	Upper Bound
2 - 2.5 kg	9	.611	.7817	.2606	.010	1.212
2.51 - 3 kg	28	.196	.8750	.1654	-.143	.536
3.1 - 3.5 kg	32	-.172	.9035	.1597	-.498	.154
>3.5 kg	7	.500	.9574	.3619	-.385	1.385
Total	76	.118	.9124	.1047	-.090	.327

Descriptives

TV1(MM)

	Minimum	Maximum
2 - 2.5 kg	-.5	2.0
2.51 - 3 kg	-1.0	2.0
3.1 - 3.5 kg	-2.0	1.0
>3.5 kg	-1.0	2.0
Total	-2.0	2.0

ANOVA

TV1(MM)

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	6.071	3	2.024	2.585	.060
Within Groups	56.363	72	.783		

Total	62.434	75			

TABLE 31: T WAVE AMPLITUDE BY GENDER

Group Statistics

	SEX	N	Mean	Std. Deviation	Std. Error Mean
TV1(MM)	MALE	40	-.050	.8305	.1313
	FEMALE	36	.306	.9730	.1622

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means	
		F	Sig.	t	df
TV1(MM)	Equal variances assumed	1.764	.188	-1.718	74
	Equal variances not assumed			-1.704	69.232

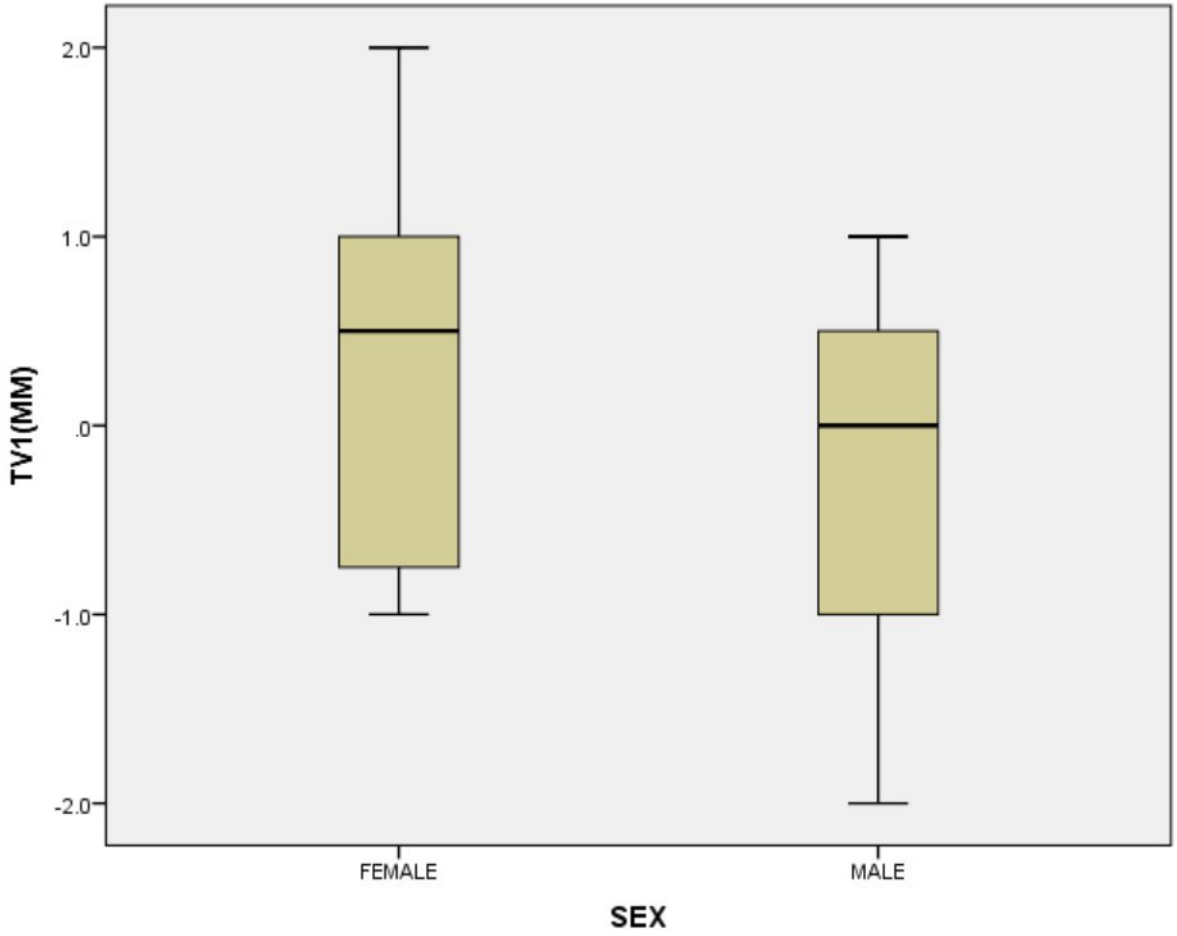
Independent Samples Test

		t-test for Equality of Means			
		Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference
					Lower
TV1(MM)	Equal variances assumed	.090	-.3556	.2069	-.7679

	Equal variances not assumed	.093	-.3556	.2087	-.7718

Independent Samples Test

		t-test for Equality of Means
		95% Confidence Interval of the Difference
		Upper
TV1(MM)	Equal variances assumed	.0568
	Equal variances not assumed	.0607



DISCUSSION

1. **Lue et.al**.(9) study showed that the in first 72 hrs of life the mean heart rate was132/min with the sd of 13.07 with 5th and 95th percentile wre 111and 152 respectively. Davignon et.al(10)study ,the mean heart rate was 145/min ,range(90-180)in newborn of montreal.

In our study the mean heart rate was 125.75/min with the sd of 15.44

2. **Afolabi Joseph Kolawole, S.I.Omokhodion** (2),the mean PR inv was 120 mswith 2nd and 98th percentile were 80&140 respectively in in 0-7 days of newborn in Nigerian population.. Davignon et.al(10) ,the mean PR inv was 100ms in newborn of montreal.

In our study the mean PR inv was 102.67 ms with SD of 12.978 correlating with davignon et.al study

3. **Lue et al**(11) study,the mean QRS duration was 71 ms with SD of 11.5 with 5th percentile & 95th percentile of 57 and 89 ms respectivelyin 1-3 days of newborn.

In our study, the mean QRS duration was 61.47 ms with SD of 8.709 with 5th percentile & 95th percentile of 44.8 and 76 ms respectively.

4. **Marti –Almor et.al**(6) study showed that in Spanish children ,the mean QTc by bazett formula was 417.79 ms with sd of 28.47 ms. In the same study he mentioned that 28.2% of Indian and Pakistani newborn infants has prolonged QTc inv compared to 17.9% of the Spanish newborn, when they used the bazett formula.
5. **Lue et al**(7),the mean QTc inv (bazett) was 412ms with sd of 23.09 with 5th percentile & 95th percentile of 380 and 451 ms respectively1-3 days of newborn.

Afolabi Joseph Kolawole, S.I.Omokhodion(2),the mean QTc inv was 400ms with 2and 98 percentile were 350 and 470 ms respectively in the newborn 0-7 days of life..

Bazett's formula is the most commonly used due to its simplicity. It

over-corrects at heart rates > 100 bpm and under-corrects at heart rates <

60 bpm, but provides an adequate correction for heart rates ranging from 60 – 100 bpm. At heart rates outside of the 60 – 100 bpm range, the Fredericia or Framingham corrections are more accurate and should be used instead(8)

In my study the mean QTc inv observed by the bazett formula was 405.49 ms with sd of 42.013 with 5th percentile & 95th percentile of 330.55 and 472.75 ms respectively. Prolonged QTc inv(by bazett) was observed in 26.31% of the study population. But when I used the Fridericia formula none of them showed the prolonged QTc inv.The mean QTc interval Fridericia formula 357.14 ms, sd of 34.072ms with 95%CI for mean349.36-364.93 ms.

There was the statistical difference between the QTc by Bazett and Fridericia formula which is statistically significant p 0.000.

5.

Mean	**S.I.Omokhodion** (2^{nd} &98 per)(2)	**Lue et** al(5^{th}&95)	**Davignon**	**Our study** (5^{th}&95^{th})
P axis	47 (0.3-49.4)	47(17-74)		44.72(22&70)

QRS axis	127(60-180)	122(87-177)	110	115.49(91&151)
T axis	43(0-179)	22(-19&65)		39.87(-19&62)

This clearly shows the right axis deviation of the right ventricular hypertrophy.

6. **Valimaki et al**(1) mean R wave Amplitude in V1 was 12.6mm with the range of 6mm-19mm in the study conducted in the newborns of municipal maternity hospital,Turku.

Afolabi Joseph Kolawole et al(2) study mean R wave Amplitude in V1 was 15mm with 2nd and 98th percentile 4 and 26 mm respectively in newborn of 0-7 days of life in Ilorin ,Nigeria.

Rijnbeek et al (3)showed that the mean R wave amplitude in that study was 11mm with 98 the percentile of 20.5mm in age group of 0-1 month.

Lue et al(4) study showed that the mean R wave amplitude in V1 was 8.6mm+/-3.5 mm with 5 th and 95 the percentile was 3.5 mm and 15.1 mm respectively in newborn 1-3 days of life.

William hancock et al in JACC, (5)for the pathological right ventricular hypertrophy had given the cut off of 27mm and the study also tells that

African-american population will have the upper normal range of QRS amplitude than the others.

In our study the mean R wave amplitude was 11.56mm with SD of 2.96 mmwith 5 th and 95th percentile 6.85 mm and 16.15 mm respectively. This mean R wave amplitude was lower than Valimaki et al study in Turuku population and Afolabi Joseph Kolawole study in the Nigerian population.This clearly shows that the racial difference is seen in the amplitude of the R wave in the lead V1 which inturn tells that the difference in the physiological right ventricular hypertrophy.

HRS OF LIFE	**MEAN 'R'WAVE AMP(MM) IN V1**
0-24	15.33
25-48	12.14
49-72	7.56
TOTAL	11.56

The above table **in my study** clearly shows that the physiological right ventricular hypertrophy gradually regresses as the time advances. The difference in the mean value between the age groups are statistically significant (P=0.000)

7. **Edemeka et al** (12) the mean S wave amplitude in V6 was 3 mm with the 2nd and 98 the percentile were 0 and 12 mm respectively(12).

In our study the mean S wave amplitude was 3.59mm with the sd of 1.644mm,correlating with that the study.

HRS OF LIFE	**MEAN 'S'WAVE AMP(MM) IN V6**
0-24	4.17
25-48	3.89
49-72	2.42
TOTAL	3.59

The difference in the mean value between the three age groups are statistically significant P 0.002. This clearly shows that the physiological right ventricular hypertrophy gradually regresses as the time advances

8. **In my study,**

HRS OF LIFE	**MEAN RV1+ SV6 AMPLITUDE(MM)**

0-24	19.5
25-48	16.03
49-72	9.97
TOTAL	15.14

This clearly shows that the physiological right ventricular hypertrophy gradually regresses with the time.the difference between the groups was statistically significant P 0.000

9.**Lue et al**(54) study showed that mean V1(R/S) ratio was 6.69 +/- 9.09 with 5th and 95 th centile were 0.64 and 22.75 respectively in 1-3 days of life.

In our study the mean V1(R/S) ratio was 6.31 +/- 3.9 with 5th and 95th centile were 2.14 and 15 respectively. This shows that the predominant right ventricular force in the newborn period

10. MEAN R WAVE AMPLITUDE IN V6

STUDY	MEAN R WAVE V6 AMP(MM)
Valimaki et al,Turuku(1)	8.7
Joseph Kolawole et al,Nigeria(2)	6

Lue et al,taiwan(55)	6.6
Our study	4.82 (95%CI 4.34-5.29)

This shows that the ethnic difference in the left ventricular forces also because our mean value is lesser when compared to the Turuku,Nigerian ,and the Taiwan population.

CONCLUSIONS

1. The mean R wave amplitude was 11.56mm with SD of 2.96 mm with 5 th and 95th percentile 6.85 mm and 16.15 mm respectively for the Indian population.

2. The mean QTc inv observed by the bazett formula was 405.49 ms with sd of 42.013 with 5th percentile & 95th percentile of 330.55 and 472.75 ms respectively.

3. The mean QTc interval Fridericia formula 357.14 ms, sd of 34.072ms with 95%CI for mean349.36-364.93 ms. The measurement of QTc by fridericia formula predicts QTc more correctly in the new born since the newborn heart rate is usually more than 100/min

4. The mean heart rate was 125.75/min with the sd of 15.44 with 5^{th} and 95^{th} percentile 93.7&149 /min respectively.

5. The mean PR inv was 102.67 ms with SD of 12.978 with 5^{th} and 95^{th} percentile 82&126.15 ms respectively.

6. The mean QRS duration was 61.47 ms with SD of 8.709 with 5th percentile & 95th percentile of 44.8 and 76 ms respectively

7. The mean P wave axis in Indian population was 44.72 degree , 5&95^{th} percentile of 22&70 respectively.

8. The mean QRS wave axis in Indian population was 115.49 degree , 5&95th percentile of 91&151 respectively

9. The mean T wave axis in Indian population was 39.87 degree , 5&95th percentile of -19&62 respectively

DISCLOSURE:
The investigator had not received any form of support or grant from any institution or pharmaceutical company.

1. Valimaki I. Tape recordings of the electrocardiogram in newborn infants. Acta paediatrica Scandinavica Supplement. 1969;199:1-80.
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ANNEXURES

PROFORMA

NEWBORN NAME :

AGE(HRS. OF LIFE) :

SEX :

BIRTH WEIGHT OF THE BABY :

RESIDENTIAL ADDRESS :

PARITY OF THE MOTHER :

SYSTEMIC ILLNESS OF THE MOTHER :

ELECTROCARDIOGRAPHIC DETAILS :

HEART RATE :

P WAVE DURATION :

PR INTERVAL :

QRS DURATION :

QT,QTc INTERVAL :

P,QRS,T WAVE AXIS :

R WAVE AMPLITUDE IN V 1 :

S WAVE AMPLITUDE IN V 6 :

R V1 +SV6 :

R WAVE AMPLITUDE IN V 6 :

S WAVE AMPLITUDE IN V 1 :

V1(R/S) :

PATIENT CONSENT FORM

Study detail : EVALUATION OF MEAN 'R' WAVE AMPLITUDE IN LEAD V1 OF ECG AMONG TERM NEWBORN INFANTS

Study Centre : GOVT. KILPAUK MEDICAL COLLEGE HOSPITAL ,CHENNAI.

Patients Name :

Patients Age :

Identification Number :

Patient may check (✓) appropriately:

I confirm that I have understood the purpose of procedure for the above study. I have the opportunity to ask question and all my questions and doubts have been answered to my complete satisfaction.

I understand that my participation in the study is voluntary and that I am free to withdraw at any time without giving reason, without my legal rights being affected.

I understand that sponsor of the clinical study, others working on the sponsor's behalf, the ethical committee and the regulatory authorities will not need my permission to look at my health records,both in respect of current study and any further research that may be conducted in relation to it,even if I withdraw from the study I agree to this access. However, I understand that my identity will not be revealed in any information released to third parties or published, unless as required under the law. I agree not to restrict the use of any data or results that arise from this study.

I agree to take part in the above study and to comply with the instructions given during the study and faithfully cooperate with the study team and to immediately inform the study staff if I suffer from any deterioration in my health or well-being or any unexpected or unusual symptoms.

I hereby consent to participate in this study.

I hereby give permission to undergo complete clinical examination and diagnostic tests including hematological, biochemical, radiological tests.

Signature/thumb impression:

Patients Name and Address: place date

Signature of investigator :

Study investigator’s Name : place date

நோயாளி ஒப்புதல் படிவம்

ஆராய்ச்சியின் விவரம் :

ஆராய்ச்சி மையம் : அரசு கீழ்பாக்கம் மருத்துவக் கல்லூரி மருத்துவமனை

நோயாளியின் பெயர் : நோயாளியின் வயது:

பதிவு எண் :

நோயாளி கீழ்கண்டவற்றுள் கட்டங்களை (✓) செய்யவும்

1 மேற்குறிப்பிட்டுள்ள ஆராய்ச்சியின் நோக்கத்தையும் பயனையும் முழுவதுமாக புரிந்து கொண்டேன். மேலும் எனது அனைத்து சந்தேங்களையும் கேட்டு அதற்கான விளக்கங்களையும் தெளிவுபடுத்திக் கொண்டேன். ☐

2 மேலும் இந்த ஆராய்ச்சிக்கு எனது சொந்த விருப்பத்தின் பேரில் பங்கேற்கிநேன் என்றும், மேலும் எந்த நேரத்திலும் எவ்வித முன்றிவிப்பு மின்றி இந்த ஆராய்ச்சியிலிருந்து விலக முழுமையான உரிமை உள்ளதையும் இதற்கு எவ்வித சட்ட பிணைப்பும் இல்லை என்பதையும் அறிவேன். ☐

3 ஆராய்சியாளரோ, ஆராய்ச்சி உதவியாளரோ, ஆராய்ச்சி உபயத்தாரரோ, ஆராய்ச்சி பேராசிரியரோ, ஒழுங்குநெறி செயற்குழு உறுப்பினர்களோ எப்போது வேண்டுமானாலும் எனது அனுமதியின்றி எனது உள்நோயாளி மற்றும் புற நோயாளி பதிவுகளை இந்த ஆராய்ச்சிக்காகவோ அல்லது எதிர்கால பிறஆராய்ச்சிகளுக்காகவோ பயன்படுத்திக் கொள்ளலாம் என்றும் மேலும் இந்த நிபந்தனை நான் இவ்வராய்ச்சிலிருந்து தகும் என்றும் ஒப்புக்கொள்கிறேன். ஆயினும் எனது அடையாளம் சம்பந்தப்பட்ட எந்த பதிவகளும் (சட்டபூர்வமான தேவைகள் தவிர) வெளியிடப்படமாட்டது என்ற உறுதிமொழியின் பெயரில் இந்த ஆராய்ச்சிலிருந்து கிடைக்கப்பெறும் முடிவுகளை வெளியிட மறுப்பு தெறிவிக்கமாட்டேன் என்று உறுதியளிக்கிறேன். ☐

4. இந்த ஆராய்ச்சிஆச்ன வாயின் அருகில் வரும் சீழ் கட்டியை குறித்தது. அந்த நோயின் தன்மையையும், பின் விளைவுகளையும் பற்றியும், அறுவை சிகிச்சையின் போது கீறி எடுக்கப்படும் சீழை பரிசோதனைக்கு அனுப்பி கிருமியின் தன்மையையும் அதற்கு உகந்த மருந்தை பற்றியும் அறிய நடத்தும் ஆராய்ச்சி என்பதை மருத்துவர் மூலம் அறிந்து கொண்டேன். ☐
5. இந்த ஆராய்ச்சிக்கு நான் முழுமனதுடன் சம்மதிக்கின்றேன் என்றும் மேலும் ஆராய்ச்சி குழுவினர் எனக்கு அளிக்கும் அறிவுரைகளை தவறாது பின்பற்றுவேன் என்றும் உறுதியளிக்கிறேன். ☐
6. இந்த ஆராய்ச்சிக்குத் தேவைப்படும் அனைத்து மருத்துவப்பரிசோதனைகளுக்கும் ஒத்துழைப்பு தருவேன் என்று உறுதியளிக்கிறேன். ☐
7. இந்த ஆராய்ச்சிக்கு யாருடைய எற்புறுத்தலுமின்றி எனது சொந்த விருப்பத்தின் பேரிலும் சுயஅறிவுடனும் முழுமனதுடனும் சம்மதிக்கின்றேன் என்று இதன் மூலம் ஒப்புக்கொள்கிறேன். ☐

நோயாளியின் கையொப்பம் / பெருவிரல் கைரேகை
இடம்: தேதி:

ஆராய்ச்சியாளரின் கையொப்பம்:
இடம்: தேதி:

SL.NO	NAME(BABY OF)	AGE(HR	SEX	BIRTH V	PARITY	H.R	P DUR(MS)	PR INV(MS)	QRS DUR(MS	QT INV(MS)	QTC BAZETT	QTC FRID
1	FATHIMA	68	F	3.1	M	136	52	88	58	270	409	355
2	SANDHIYA	10	M	3.6	P	129	60	100	70	280	420	361
3	JANAKI	56	F	2.6	M	105	53	84	70	336	445	405
4	BHAVANI	52	M	3.2	P	149	56	113	65	265	420	359
5	RANI	12	F	2.7	M	126	61	96	70	289	418	370
6	JOTHI	66	F	3.7	M	126	50	81	64	282	414	361
7	RANJANA	26	M	3.3	P	131	61	98	68	286	420	371
8	NANDHINI	52	F	2.8	M	101	65	87	61	252	331	300
9	GEETHA	58	M	2.6	P	126	48	82	62	265	389	339
10	VIJAYA	30	F	3.6	M	118	52	108	58	270	385	338
11	PRIYANKA	32	F	3.4	M	132	48	96	65	275	407	358
12	DURGA	28	M	2.9	M	134	54	112	76	254	384	332
13	SOUNDARYA	62	F	3.5	P	112	36	116	58	273	379	336
14	SIVAKUMARI	66	F	2.6	M	107	46	109	62	257	347	312
15	KALYANI	16	M	3.1	M	115	35	126	42	302	419	375
16	SABITHA	64	F	2.7	P	121	60	115	72	272	388	344
17	MARIYA	32	M	3.2	M	141	65	116	52	286	446	380
18	DURGA	68	F	2.8	P	121	40	88	62	252	360	319
19	SRIPRIYA	70	M	3.3	M	124	38	105	52	251	363	320
20	KARTHIGA	34	F	3.2	P	108	41	92	55	286	386	348
21	KOKILA	42	F	2.6	M	153	38	107	65	256	409	350
22	DHANAPRIYA	14	M	2.9	P	136	36	99	45	268	404	352
23	REVATHY	32	F	2.1	M	149	36	121	62	316	494	425
24	BHUVANESHWARI	16	M	2.4	M	142	47	141	54	306	471	408
25	RATCHEL	28	F	2.3	P	111	52	62	78	326	444	400

P AXIS	QRS AXIS	T AXIS	R V1(MM)	SV6(MM)	RV1+SV6	RV6(MM)	SV1(MM)	RV6+SV1	V1(R/S)	QIII(MM)	QV6(MM)	TV1(MM)
76	139	55	6	4	10	3	1	4	6	2	1	-1
75	165	45	15	6	21	6	1	7	15	3	1	-1
38	102	30	9	1	10	6	4	10	2.25	2	0.5	1
42	124	55	7	4	11	3	1	4	7	1.5	0.5	-0.5
75	162	41	15	7	22	7	1	8	15	2.5	0.5	-1
56	75	21	8	4	12	3	2.2	5.2	3.63	1.5	0.8	0
67	131	25	11	5	16	5	2	7	5.5	2	1	-1
35	92	51	6	0.5	6.5	4	3	7	2	1.5	0.5	2
41	98	35	8	3	11	3	1	4	8	1.5	0.5	0
52	115	43	13	5	18	5	1	6	13	2	1	0
42	98	25	9	3	12	2	2	4	4.5	1.5	0.5	-1
49	122	20	10	5	15	4	1	5	10	3	1	0
38	112	40	8	1	9	6	4	10	2	2	0.5	1
52	127	41	7	2	9	3	1	4	7	1	1	0
45	120	46	16	6	22	5	1	6	16	1.5	0.5	-0.5
36	120	26	8	3	11	2.5	1.5	4	5.33	1.5	1	-1
46	96	28	13	4	17	3	2	5	6.5	1.5	1.5	-2
35	96	30	9	1	10	5	4	9	2.2	2	0.5	1
36	113	32	8	3	11	2	1	3	8	1.5	0.5	0
50	151	48	14	6	20	6	1	7	14	2	0.5	-0.5
56	127	19	12	0	12	3	6	9	2	1	0.5	1
53	108	66	18	4	22	5	3	8	6	1	0.5	0.5
52	136	59	14	5	19	9	1	10	14	2	0.5	-0.5
21	91	34	16	4	20	5	4	9	4	2	1	1
56	121	45	10	5	15	7	1	8	10	0.5	0.5	2

25	RATCHEL	28	F	2.3	P	111	52	62	78	326	444	400
26	ANITHA	30	M	3.1	M	113	64	95	72	262	360	324
27	UMA	16	F	2.8	M	125	37	93	45	272	393	347
28	ANJALAI	36	M	2.9	P	121	55	127	62	317	451	401
29	HEMALATHA	18	M	2.2	M	126	56	112	63	316	458	405
30	KANJANA	40	F	3.4	P	118	63	92	65	285	400	357
31	MUTHAMILARASI	38	F	3.6	M	148	52	106	62	244	383	330
32	REVATHI	14	M	3.2	P	136	42	104	62	268	404	352
33	DHANAPRIYA	32	M	2.7	M	127	61	125	72	302	440	388
34	UDAYAKUMARI	38	F	2.9	M	109	41	98	65	309	417	377
35	VAYALET	44	M	3.4	P	136	42	136	62	232	351	305
36	JEYANTHI	46	F	3.7	M	115	56	108	63	322	446	400
37	LATHA	12	M	2.6	P	141	63	94	71	257	394	342
38	GOMATHI	28	F	2.7	M	136	65	112	63	262	395	344
39	KAVITHA	42	M	2.2	P	147	46	113	53	312	488	421
40	MEENATCHI	36	F	2.9	P	152	36	82	42	245	390	334
41	BHANUPRIYA	30	M	3	M	135	46	113	61	252	365	319
42	NAGAVALLI	42	F	2.3	P	125	53	119	62	308	445	343
43	JEEVA	58	M	3.5	M	113	51	104	67	313	430	387
44	MAHALAKSHMI	38	F	2.3	M	124	48	85	76	331	477	422
45	MEERA	40	F	3.2	M	139	50	87	74	290	442	384
46	SAMSARBEGAM	28	M	3.1	M	131	38	107	68	243	359	315
47	LAKSHMI	42	F	2.6	P	121	61	105	63	286	407	362
48	JHANSI	68	M	2.8	M	119	39	93	63	301	424	378
49	PRABHA	36	M	3.2	P	131	54	107	62	238	352	309
50	PUSHPALATHA	32	M	3.8	M	135	55	92	79	283	425	371

58	132	21	11	0.5	11.5	2	5	7	2.2	1.5	0.5	1
50	112	68	17	4	21	5	3	8	5.7	0.5	0.5	1
52	136	62	15	3	18	8	1	9	15	0.5	0.5	0.5
52	131	41	16	6	22	5	6	11	2.6	1.5	0.5	0.5
35	136	22	11	4	15	6	1	7	11	1	0.5	1
21	98	25	13	0.5	13.5	2	4	6	3.2	1	0.5	1
58	122	61	16	3	19	6	3	9	5.3	1	0.5	0
63	109	42	13	6	19	8	1	9	13	2	1	1
47	127	56	12	4	16	4	4	8	3	2	0.5	0.5
28	106	32	12	4	16	5	2	7	6	1.5	0.5	1
41	115	22	13	1	14	3	5	8	2.6	1	0.5	2
42	109	36	17	4	21	4	2	6	8.5	0.5	0.5	-1
43	97	31	12	5	17	7	1	8	12	2	0.5	1
22	109	32	13	4	17	4	6	10	2.16	3	1	1
32	125	38	13	7	20	5	3	8	4.3	2	1	0
55	103	49	10	5	15	4	2	6	5	1	1.5	-1
52	112	61	10	4	14	7	3	10	3.3	1	0.5	0.5
45	106	52	6	3	9	2	2	4	3	1	0.5	-0.5
32	100	31	10	2	12	6	3	9	3.3	2	0.5	1
69	135	22	13	3	16	8	1	9	13	2	0.5	1
48	122	35	11	5	16	3	4	7	2.7	1	1.5	-0.5
41	137	46	12	5	17	11	3	14	4	2	0.5	0.5
49	112	56	7	2	9	3	2	5	3.5	2	0.5	-1
22	151	15	13	3	16	7	2	9	6.5	2	0.5	1
61	126	28	12.5	4	16.5	7	2	9	6.25	1.5	0.5	0.5

51	LAKSHMI	40	F	3.4	M	119	45	105	63	261	368	328
52	KARPAGAVALLI	34	M	3.1	P	129	63	104	52	305	447	394
53	RANI	66	F	2.9	M	129	28	106	49	293	430	378
54	JAYASREE	36	M	2.8	P	109	33	91	51	326	440	398
55	DELHIRANI	28	M	3.2	M	142	49	89	69	291	448	388
56	MEGALA	42	M	3.3	M	116	41	107	49	255	355	318
57	PUSHPALATHA	46	F	2.3	P	139	52	103	55	298	454	395
58	KAMATCHI	70	M	3.4	M	146	45	98	56	302	472	407
59	TAMILILAKYA	40	M	2.6	P	113	39	103	62	313	430	387
60	USHARANI	28	M	2.8	M	136	53	102	73	282	425	370
61	MALLIKA	18	F	3.1	P	89	47	106	68	244	297	278
62	YOGAVATHI	40	M	3.2	M	118	64	112	72	273	383	342
63	PRIYA	36	F	3.6	P	148	38	102	56	292	459	395
64	ANJANA	66	M	3.5	M	92	41	95	61	265	328	306
65	VIJAYALAKSHMI	34	F	2.9	P	92	56	103	63	262	324	302
66	PARIMALA	42	M	3	M	107	34	96	50	256	342	311
67	VEMBU	14	M	2.4	M	142	66	101	74	301	462	401
68	ABIRAMI	40	F	3.1	M	137	35	109	61	277	419	365
69	KRISHNAVENI	16	M	2.7	P	113	36	102	49	273	375	337
70	SUMATHI	36	M	2.8	M	94	53	92	58	273	342	317
71	LATHA	30	M	3.3	M	107	76	95	64	298	398	362
72	KALPANA	28	F	3.4	P	143	41	116	45	242	374	323
73	BHAGYA	54	M	3.2	M	104	52	109	61	269	354	323
74	AMMU	40	F	3.1	P	141	52	108	61	253	388	337
75	KAVITHA	58	M	3.1	M	131	49	106	63	295	436	383
76	TAMILARASI	42	F	3.4	M	145	31	92	44	272	419	363

42	117	63	12	4	16	4	3	7	4	2	1	-1
32	101	41	11	4	15	9	2	11	5.5	2	0.5	-0.5
51	109	46	7	3	10	2	1	3	7	1.5	0.5	-1
25	112	31	11.5	3	14.5	6	4	10	2.875	1.5	0.5	0.5
47	119	25	11	4	15	6.5	2	8.5	5.5	1	0.5	1
37	96	42	10	3	13	3	3	6	3.3	1	0.5	-0.5
61	139	45	12	4	16	5	2	7	6	2	0.5	-0.5
62	123	56	8	3	11	3	2	5	4	1.5	0.5	-0.5
32	107	41	10.5	2	12.5	6	3	9	3.5	2	1	0.5
53	125	41	13	5	18	7	3	10	4.3	1	1	0.5
38	115	49	16	2	18	1	4	5	4	2	1	-1
61	118	45	12	5	17	6	3	9	4	1	1	0.5
19	91	41	14	4	18	5	2	7	7	2	1	1
41	107	36	7	2	9	3	2	5	3.5	2	0.5	-1
31	96	15	14	2	16	2	4	6	3.5	2	1	-1
36	131	51	12	6	18	7	3	10	4	2	0.5	1
55	124	40	12	3	15	6	1	7	12	2.5	0.5	0.5
22	99	42	15	4	19	6	2	8	7.5	2	1	-1
29	92	34	10	1	11	3	3	6	3.3	2	0.5	1
33	91	41	15	2	17	2	4	6	3.7	1.5	1	-1
56	126	62	9	4	13	4	4	8	2.2	0.5	0.25	-1
38	102	25	13	4	17	5	2	7	6.5	2	1	1
39	97	41	8	1	9	3	2	5	4	2	1	-1
42	108	36	14	4	18	5	1	6	14	2	1	1
44	131	56	9	3	12	3	2	5	4.5	2	0.5	-1
31	92	41	14	7	21	9	1	10	14	2	0.5	1